# The Reduction of Domestic Flies

EDWARD H. ROSS

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# THE REDUCTION OF DOMESTIC FLIES

BY EDWARD HALFORD ROSS

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"The Prevention of Fever on the Suez Canal"

WITH ILLUSTRATIONS

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# The Reduction of Domestic Flies

## INTRODUCTION

The object of this book is to bring to public notice the necessity for the reduction of domestic house-flies in cities, towns, villages, and rural districts. There is a great deal of evidence to show that these insects are directly concerned in the spread of certain diseases, and therefore every effort should be made to sway public opinion in favour of fly-reduction. The experience that has been gained on the Suez Canal, where mosquito-reduction has resulted in a great amelioration of the public health, is now applied for advising similar measures against flies. In some countries anti-fly campaigns are in progress, but in Great Britain little has so far been done generally to attack this problem; some individual efforts have been made, but these are few and far between.

It has been said truly that many of our greatest ills are born of little things; the statement certainly applies to disease. Many diseases are probably borne by flies, and flies are little things producing big effects in the health of the community. But besides their disease-carrying capabilities, flies are a dis-

gusting pest which should be put down if possible. Then the ravages caused by common house-flies among children especially seem to be so little known—or are so commonly ignored—by the general public that an attempt to describe the knowledge which has been gained during the past few years and a method of applying that knowledge is well justified. It is of the utmost importance that this knowledge should be disseminated, because flies can be easily reduced in numbers, and the diseases conveyed by them may thus be prevented to some considerable extent. Scientific research, the gaining of knowledge, is of little use unless it is followed by the practical application of the discoveries made. Too often important observations are published in scientific memoirs or read before scientific societies, and they then remain buried in the obscurity of the bookshelf for years until somebody realises the possibility of their practical application and usefulness.

So it is with our knowledge concerning the dangers of house-flies. It has been known for years that the common domestic fly, *Musca domestica*, can convey typhoid fever and infantile enteritis from one person to another, but little organised attempt seems to have been made to bring such knowledge to public notice or to induce authorities concerned to reduce the numbers of these insects in localities where they do the most harm. This is due to ignorance, perhaps, or to that apathy which has been said to exist appertaining to all matters concerning the diseases which destroy human life. But it seems more probable that this apathy is really due to the fact that the general public has not grasped the essentials which are known concerning many of these diseases.

Probably the public does not realise that several of the maladies which afflict human beings can be prevented, and that prevention is better than cure—and, indeed, is often cheaper and easier.

The prevention of disease is a matter which concerns established authority, and it is to those in authority that appeal should be directed. But some years' experience of public-health work in various parts of the world has resulted in learning the lesson that established authority will not move—it will not even interest itself—unless it is pushed by the weight of public opinion. A representative organisation—municipality, town or parish council, local committee, etc.—will rarely consider a new measure, even if it is for the preservation of public health, unless its members think that such a measure will be popular in one or other section of the community which it represents; and no measure can be justly popular until it is generally understood.

It is intended, then, to describe the nature of the insect known as the house-fly—its life, its danger to human beings, and the part it plays in causing sickness, death, and misery; and to show how this pest may be best reduced in its numbers, so that its dangerous influence may be lessened.

House-flies have taken their place in the general evolution of living matter. Fossils of them appear first probably in the Tertiary rocks, though many fossil insects have been found in the earlier strata, known as the Devonian; the remains of flies have been often found also in the fossil resins known as *amber*. Now, the common house-fly is almost ubiquitous; it is encountered and endured in almost every country in the world, and is met with in both the Arctic and Antarctic circles.

History has always described flies as a pest ever since the plagues of Egypt, mentioned in chapter viii. of the book of Exodus. History repeated itself during the year 1909 at Cairo, when another plague of flies occurred again after three thousand years. But on this occasion it was followed by the death of the *newly* born, not merely the *first*-born as in the biblical story; and it affected Jews and Gentiles alike. This recurrence will be more fully described in a later chapter. In many of the drawings engraved on the monuments of ancient Egypt the slaves are shown holding palm-leaves, which were used as fans and fly-flappers; so that the insects must have been a common pest quite apart from moments of divine anger. Both the Jewish Law as drawn up by Moses, and the Mohammedan Law as enunciated in the Koran, seem to aim at sanitary regulations which, if they had been carried out in their entirety, would have reduced flies and have prevented fly-borne diseases; for fly-reduction is merely a question of efficient sanitation. The Roman gentry were much bothered by flies; as is now the case in the East, the flies were very troublesome to the ancient aristocracy of the Eternal City during the afternoon siesta—a midday rest as much in vogue now in hot climates as then in Italy. Paulus Silentarius in *Anthologia Palatina* recommends the use of a bed-curtain (*conopeum*, canopy) as a substitute for the slaves' fly-flappers. Perhaps he found his slaves as lazy as the modern Indian *punkah-wallah* is to-day; or perhaps he found that his slaves enjoyed their hot-weather siestas as much as he did. Anyhow, his suggestion was a good one, and the net or curtain replaced the fly-flapper until the introduction of the electric fan, which now effectually keeps flies off sleepers' faces in hot climates. In the various

glossaries of Shakespeare that I have consulted the word *fly* is not included, and this is a curious fact. Possibly the insect is mentioned by the poet but is not considered of sufficient importance to be dwelt upon by his commentators. It has been stated that the French word for handkerchief, *mouchoir*, is derived from the word *mouche*, a fly; but the true derivation is more probably to be found in the verb *moucher*, to blow the nose. However, it seems to have been the custom in the time of the Stuarts for the gallants to wave flimsy lace handkerchiefs about in an affected manner, as if they were perpetually fending off flies; no stage cavalier is considered perfect unless he does this well. The Arabic word for fly is *dibanah*. It seems to be derived from the same source as the word *divan*, the Arabic for sofa (or the room containing it), where the wealthy Arab takes his afternoon nap.

During the past two centuries various writers have stated, in more or less general terms, that flies and other insects may convey disease; but it was not until the discoveries of Pasteur of the capabilities of micro-organisms in causing disease, and the application of those discoveries by Lister in preventing germ-growth in wounds, that the importance of flies began to be realised. With the discovery of the tubercle bacillus by Koch, and that of the typhoid germ by Eberth and Gaffky in 1880, the question of fly-carriage of disease assumed larger proportions and began to be investigated. Then the whole subject of insect-transmission of diseases received a fillip by the well-known discovery of the conveyance of malaria by mosquitos in 1897–9. It was following this last discovery that attention was seriously directed to house-flies as disease-carriers, and more practical work on the subject instituted. While

these investigations were proceeding much more information came to light. The transmission of yellow fever by the *Stegomyia* gnat, the transmission of Sleeping Sickness by tsetse flies, that of Dengue or Dandy fever by mosquitos, and three-day fever by *Phlebotomus* flies was established; the transmission of the blood-worm disease or Elephantiasis by mosquitos is probable also, though still open to experimental proof.

According to Dr. L. O. Howard, however, Chief of the United States Bureau of Entomology, to whose book, "The House-fly, Disease Carrier" I am indebted for considerable information, some researches had been carried out as early as 1888 by Celli, who showed that virulent tubercle bacilli were found in flies which had fed on the spittle of consumptives, and typhoid bacilli in flies fed on pure cultures of that bacillus; and these observations were confirmed by Hayward, Lord, Buchanan. Buchanan also demonstrated anthrax bacilli in the intestines of flies which had fed on carcasses of animals dead of that disease. Yersin, of Plague-antitoxin fame, in 1894 found many dead flies in his laboratory at Hong Kong, in which there were several animals that had died of plague. He inoculated the juices of one of these dead flies into other animals, and they also died of plague. Dr. Graham Smith, in his Report to the Local Government Board, New Series, No. 40, quoted by Howard, states that Simmons in 1892 found the germs of cholera in flies caught in a cholera mortuary; and Macrae in 1894 in India showed (Nuttall, "Insects and Disease") that flies "should be considered as one of the most important agencies in the diffusion of this disease." Tsuzuki in 1904 cultivated the germs from flies captured in houses wherein cholera had occurred in China. Nuttall states that

Veeder, writing in 1898, claimed that flies convey typhoid fever in camps. This was followed by Ficker in 1902, and Hamilton in 1903, who discovered that the *Bacillus typhosus* could be found in flies caught in houses in which typhoid fever cases had been nursed.

The discovery of the transmission of malaria by a certain species of mosquito known as Anopheline was published by Sir Ronald Ross in a series of scientific articles during the years 1897, 1898, and 1899. He proved that the protozoal parasite of malarial fever is swallowed by these mosquitos when they bite and suck the blood of persons suffering from that disease; the germ of the fever passes through a definite development within the body of the mosquito; and at length it passes into the salivary glands of the insect and is finally inoculated with the saliva into other persons, and in this way the disease is disseminated. House-flies, however, do not convey disease in this manner, for they do not bite or suck blood; but they do deadly work in a more mechanical or accidental way. The house-flies are a disgusting pest which feed and wallow in filth of all sorts, and when their proboscides and legs are covered with germs which are growing and living in such filth, they proceed to our food and to the food of our children and contaminate it. This infected food we human beings eat and drink, and in this way disease is kept circulating from one person to another in a never-ending cycle, the flies carrying disease from one sick person to the food of others and perhaps to and from animals besides.

Following the discovery of the transmission of malaria by the agency of the mosquitos the similar conveyance of yellow fever was proved. Then during the Spanish-American War the part played by flies in

the conveyance of typhoid fever became a matter of importance. During that war, one-fifth of the soldiers in the United States Army camps contracted the disease, while, according to Vaughan quoted by Howard, more than 80 per cent. of the deaths were due to typhoid. During the Boer War in South Africa, typhoid fever raged, and enormous numbers of our soldiers died of it—the Bloemfontein epidemic will be remembered by every one. Although the water-supply was generally condemned at the time, there is little doubt that flies played a great part in disabling more British soldiers than the bullets of the enemy; the insects cost the nation vast sums of money and many lives. The camps, the hospitals, even the bivouacs were generally fly-infested. The flies used to breed in the stables, the horse-lines, the latrines, and in and about the camps, and they sometimes followed the columns on the march. They were a terrible pest, and nothing practical was done to prevent them or to reduce their numbers. During the epidemic of typhoid, Bloemfontein was fly-infested, and many of these insects must have been infected with typhoid germs. And these flies must be held responsible for some of the cost of that war; it is a wonderful thing to consider that house-flies should have been the means of the prolongation of war, the expenditure of many lives and much money; and the cause—a tiny creature like the domestic fly. The idea would be almost ludicrous were it not so pitiful and humiliating.

But little or nothing is being done to prevent house-flies now, although they are responsible for the loss of many lives annually at the present time in the British Islands. For recent research has shown

that house-flies may convey several diseases besides typhoid fever, cholera, and tuberculosis, namely anthrax, ophthalmia, swine-fever, possibly diphtheria and small-pox. But there is one other most important disease which there can be little doubt is carried by flies—it is infantile enteritis. This disease kills thousands of children in the world every year; it is prevalent here in England, and is a cause of a considerable infantile mortality. Yet very little is done by the community generally to prevent flies. Flies cannot be exterminated, but their numbers can be reduced very readily. And the reason why this is not done is that those responsible for safeguarding the public health do not realise how easy it is to reduce the number of flies, and to prevent the diseases they convey. At Port Said, where there was an anti-mosquito campaign in full progress, the organisation was employed for a short period to make an experiment in fly-reduction. The experiment, so far as it went, was very successful, and it can be done anywhere.

In addition to the danger of house-flies as carriers of disease from one person to another, these insects are a loathsome pest. On warm summer days one has only to watch them swarming round the dust-bin, or to see them attracted by any garbage, manure, or filth, and then to observe them feeding on our food and bathing their filthy feet in the milk-jug, or walking about the sugar, or sprawling in the jam. Or look at them crawling on the window-pane, or feel them buzzing round our mouths and eyes; in the early morning they persistently attack our nostrils. Glance at the glass of the window and see the marks they make. Do they leave the same marks on our food and on our faces? Undoubtedly they do. They infest

the food, they infect the food, and the children die. It is not the food which kills our infants but the flies' mark upon it. Surely it is time we did something to prevent or reduce this pest.

The reduction of domestic flies is a simple matter, but it must be persevered with. Flies are best attacked while they are in the larval or maggot stage of their existence, for then it is easy to destroy them in large numbers. It is, of course, also easy to trap or kill many of the flying insects in a room; but then more will fly in to take the place of the dead ones. Whereas if the larvæ are dealt with, instead of accounting for at most a few hundreds, they can be killed in their thousands. Besides, prevention is better than cure.

The house-fly breeds in all sorts of filth, but stable manure is the commonest lair for this insect. The female fly likes to lay her eggs here, and in the horse-dung the fly-maggot or grub lives for five days and then becomes a chrysalis or nymph (pupa). This stage commonly lasts another five days, after which the fully developed flying insect or *imago* so familiar to us all emerges to do its deadly work in the world. It is during the former stages that the insect can be found in its numbers collected together, and it is during these stages that it can be easily destroyed, for it gives us ten days in which to look for it while it is crawling, and to take such measures as we conveniently can against it. It is a simple process. All manure, ash-bins, dust-heaps, privies, etc., should be inspected once every week regularly for fly-larvae and the material containing the larvae destroyed. If this was done in every town and village regularly and perseveringly there would soon be a reduction of flies, and with the flies would go much typhoid fever, and many infants'

lives would be saved, for there would be no enteritis. This would mean the saving of money, for, as will be shown later, lives mean money to the nation, and also much misery would be avoided. Yet the measures suggested are merely those of ordinary sanitation—an efficient sanitary scavenging service. But until the public realise the importance of domestic flies and the part they play in producing disease and death, the measures against flies will not be generally undertaken as a routine even by modern sanitary authorities. If every one could be induced to take an interest in their own healths, their lives, and those of their children, flies would soon be reduced to a negligible number even during heat-waves and in tropical countries, where this pest abounds more than at home.

Flies in a town, village, or house should be regarded as a sign of insanitation, and their numbers as a measure of that insanitation. Fly-reduction is a beneficial measure.

1. It means a saving of life and therefore of money.
2. It reduces sickness, sorrow, misery.
3. It results in a riddance of a pest.
4. It entails a better sanitary inspection, the discovery of insanitary conditions and places.
5. It improves our knowledge of certain diseases.
6. Its cost is small.

Since it is generally agreed that it is the duty of every one to prevent disease, it is obviously the duty of every one to prevent, or at all events to reduce, the dangerous domestic flies which produce disease.

# CHAPTER I

## THE IMPORTANCE OF DOMESTIC FLIES

The discovery of the mode of transmission of the malarial fevers by certain mosquitos was followed by the practical application of the knowledge gained; the disease was prevented in many places by the reduction of mosquitos. In several important centres, for example on the Suez and Panama Canals, this disease has been almost abolished. When it was proved that yellow fever was carried by another species of mosquito, the domestic Culecine, these in their turn were dealt with and reduced in many places and the disease abolished, for example, at Havana, Rio, New Orleans, Panama. But the discoveries concerning the transmission of diseases by house-flies which have taken place have not yet been followed by much practical application, and but little organised attempt has been made to reduce these insects too. This is partly because the proofs of the damage done by flies are not so thoroughly established as those concerning the mosquito-borne diseases. As stated before, the house-fly does not bite, and when it conveys disease it does so accidentally, it is not possessed, as it were, of the malice aforethought which the mosquito possesses in her lust for blood; the fly does not transfer the germs of disease direct from the blood of one person to the blood of another, but she takes the germs from the

excretions of one to the food of another. Thus the fly is more subtle in its methods, but the way is surer, for helpless children are infected at a tender age; and the fly runs less risk to her own life than does the mosquito, because as the former does not bite we have less desire to kill her in moments of rage.

The discovery of the mode of transmission of malaria was published at the end of the last century, and that of yellow fever during the first years of the present century. Then the fly question began to be taken up seriously, and the Spanish-American and Boer Wars brought in their train a mass of evidence inculpating this insect in the spread of typhoid. According to Dr. Graham Smith, in his Report to the Local Government Board 1909, it is stated that during the typhoid epidemic in the Southern camps in Florida while the former campaign was in progress there were countless flies; these were breeding in the sewage pits usually placed near the kitchen tents. The largest number of cases of typhoid occurred among the cavalrymen—the way in which horses attract flies is well known; it was noted at the time how the flies went from the sewage pits to the kitchens. The Report quotes: "It was impossible to keep the flies from the already cooked food even if a man kept one hand over his plate and ate with the other." The American Army Medical Department issued a circular to the effect that flies are probably carriers of typhoid. "They swarm about fæcal matter and filth of all kinds deposited on the ground or in shallow pits, and directly convey infectious material attached to their feet or contained in their excreta to the food which is exposed." Walter Reed, who was a member of the American Commission which discovered the part played by

mosquitos in the transmission of yellow fever, also reported on the typhoid epidemic in the camps in Cuba during the Spanish-American War; and he believed that the outbreaks were certainly due to food contaminated by flies. Vaughan, another member of the United States Army Typhoid Commission, concluded in his Report: (*a*) Flies swarmed over infected fæcal matter in the pits, and then visited and fed on the food prepared for the soldiers in the mess-tents. When lime had been recently sprinkled over the contents of the pits, flies with their feet whitened with the lime were seen walking over the food. (*b*) Officers, whose mess-tents were protected by means of screens, suffered proportionately less from typhoid fever than did those whose tents were not so protected. (*c*) Typhoid fever gradually disappeared in the fall of 1898 with the approach of cold weather and the consequent disabling of the fly.

Howard continues to quote Dr. Vaughan's Report: "It is possible for the fly to carry the typhoid bacillus in two ways. In the first place, fæcal matter containing the typhoid germ may adhere to the fly and be mechanically transported. In the second place, it is possible that the typhoid bacillus may be carried in the digestive organs of the fly and be deposited with its excrement." This last suggestion of Dr. Vaughan's is most interesting, for the India Plague Commission has shown that the bubonic plague may be conveyed in this manner by rat-fleas from rat to rat and from rats to human beings.

During the Boer War the relation of flies to typhoid was noticed several times. Nuttall and Jepson and Graham Smith have collected much evidence from various writers. Tooth and Calverley, writing of typhoid in camps during the South African War,

state that "in a tent full of men, all apparently ill, one may almost pick out the enteric cases by the masses of flies they attract. This was very noticeable at Modder River, for at that time there were in many tents men with severe sunstroke who resembled in some ways enteric (or typhoid) patients; and it was remarkable to see the insects hover round and settle on the enterics. The moment an enteric patient put out his tongue a fly would settle on it." Again, "At Bloemfontein the flies were a *perfect* pest; they were everywhere, in and on every article of food. It is impossible not to regard them as important factors in the dissemination of enteric (typhoid) fever. Our opinion is further strengthened by the fact that enteric fever in South Africa practically ceases every year in the cold weather, and this was the case at Bloemfontein." I can confirm the statement of the above writers so far as Bloemfontein is concerned. There the house-flies were a veritable plague, and the hospitals and regimental tents and soldiers' lines were actually swarming with them. No wonder the typhoid played havoc with our Army. Pretoria told the same story. Many other writers in various parts of the world have reported similar observations regarding the carriage of typhoid by flies.

But all this evidence, though very suggestive, can only be regarded as circumstantial or inferential. It was not long, however, before more exact experimental work brought new facts to light. The work of Celli on the carriage of the typhoid bacillus has already been mentioned. But in those days the germ of typhoid was not so well known as it is now. Howard, who is an established authority on entomology, gives the following extracts as "exact" proof of the carriage

of typhoid fever by house-flies. In 1902, after the lesson of the South African War, Firth and Horrocks, of the Royal Army Medical Corps, kept some blue-bottles and some house-flies in a large box measuring 4 ft. by 3 ft. by 3 ft.; it was fitted with a glass side. The flies had been fed on material contaminated with the typhoid bacillus. Some culture-jellies were left exposed in the box, and after a few days the bacilli were found growing on the culture media. This experiment was repeated, and the typhoid germs were grown from the legs, wings, and bodies of the flies. Hamilton, at Chicago, in 1903, caught eighteen flies in and about rooms occupied by typhoid cases, and states that she found the *Bacillus typhosus* in five of them. Ficker, in 1903, caught flies in a house at Leipsig, where eight cases of typhoid had occurred; he isolated the germ from them. Dr. Graham Smith describes some experiments carried out by Ficker. He kept the flies in 10-litre flasks into which he had introduced some sugar, strips of blotting-paper, and some typhoid bacilli grown on broth. The broth was spread on the glass of the flasks, and partly absorbed by the blotting-paper. After eighteen to twenty-four hours the flies were transferred to clean flasks. He found the flies to survive over four weeks in captivity if protected from the cold and fed on sugar, bread-and-water, or milk. The flies were moved into clean flasks every two or three days. They were at last killed with ether and crushed, and their remains transferred to gelatine, on which the typhoid bacillus was found growing twenty-three days after the flies had been exposed to infection. Dr. Graham Smith concludes that "the evidence regarding the part that flies may play in the spread of typhoid fever may therefore be accepted as quite conclusive."

It is not meant by the above observations that typhoid fever is conveyed by flies alone; such a statement would be quite untrue. Typhoid fever is also carried by contaminated water, milk, and these often account for epidemics. Besides, like some other diseases, epidemics can be sometimes explained by the presence in the community of *carriers*, that is, persons who, having had an attack of the disease, continue to harbour the germs for a long time after they themselves have apparently recovered. But such persons may infect flies. Flies must often be responsible for typhoid fever, which is a very serious affection, and is found all over the world. It caused 196 deaths in London during 1910, 181 in Paris, 584 in St. Petersburg, 73 in Berlin, 82 in Vienna, 330 in Calcutta, 558 in New York, 195 in Buenos Ayres, and produced a death-rate of 0·05 per 1,000 of the population in the towns of England and Wales. Therefore typhoid fever and flies are clearly two important things to be dealt with.

But if typhoid fever and its prevention are important matters to be considered, there is a disease connected with flies which is even more important, inasmuch as it produces a much greater death-rate. It is *Diarrhœa and enteritis*, which, during 1910, killed 0·45 per 1,000 of the population in London alone.

This is a disease of children. Infants are attacked, are taken suddenly ill, and many of them succumb after a few days' illness. In London, during the year 1910, there died of this disease 1,811 infants under two years of age; and during 1911, which had a hot summer, the infantile death-rate rose to even greater proportions. But in Bombay, during 1910, 2,263 died, and in Paris this disease killed 1,152 infants, in New York 5,649, Chicago 3,384, Rio de Janeiro 2,692. Here, then, is a

formidable disease, and it is probably largely due to flies, as will be shown later.

This *infantile enteritis*, or summer diarrhœa, as it is frequently called, is the most fatal enemy to children. It is quick and sure, and it kills. It takes the infants of the poor more readily than those of the rich and well-to-do, for it finds them easier of access. But once it arrives it is no respecter of persons, and unless it is nipped in the bud it smites the coming generation; and if left to its own will it will take the healthy as well as the unhealthy, the strong and the weak, the well-born and the lowly; and when it starts working it does its work well. During the hot weather at Cairo in 1909 it killed 3,000 infants in less than two months; so it is a disease which knows no finicking methods. It is true that in civilised countries the children of the richer classes frequently escape this affection, but this is because improved sanitation has reduced flies in modern cities. In the West End of London, for example, the stables and mews have become garages, and there are only a few flies where formerly thousands pestered, and there the children escape; besides, the rich can afford to have their infants carefully nursed and tended, and early treatment often effects a cure. But this disease is one which can be prevented among the poor too. Yet, notwithstanding the fact that most important discoveries have recently been made concerning this dangerous affection, very little notice has been taken of them, and, although children die of this disease every year, little or nothing has been done to fend it off.

During the years 1905 to 1908 a series of researches were carried out by Dr. Morgan at the Lister Institute of Preventive Medicine in London. He examined

469 children suffering from infantile enteritis in the wards and out-patient departments of the various London children's hospitals. As a result, he isolated a micro-organism, which he named *Morgan I*, and this he found predominating conspicuously over all other germs in this disease. Young rats and rabbits were fed on this bacillus, and they died of acute enteritis. Then four monkeys were given the germ with their food, and they died with symptoms exactly like those of the children in the hospitals.

The question of the transmission of this bacillus from one child to another was next considered by Morgan and Ledingham. A number of flies caught in houses in which there had been children sick with infantile enteritis were examined, and the same germ was found in several. The flies were killed with ether vapour and their bodies examined, and the germ found in many instances within the flies caught.

But because infected flies were found after the onset of the cold weather in the autumn, and because some infected flies were found in a house in the country where no child suffering from the disease happened to be discovered, and because some doctors believed that the fly-*curves* and the disease-*curves* do not correspond, this research seems to have been relegated into the background.[1] It should have been named as one of the most important investigations of the present century. Flies may live for weeks in the cold weather—in fact, we know they do; but the majority die. And there may be enteritis *carriers*, as we know there

[1] Since this book was sent to press, an excellent dissertation entitled "The Insect Porters of Disease," by Dr. C. J. Martin, F.R.S., has appeared in the *British Medical Journal* and the *Lancet* of January 4, 1913.

are typhoid *carriers*, who appear apparently healthy and who have had but mild attacks of the disease. These discoveries produced some small discussion amongst medical men, but there they seem to have ended; at all events, there has been little organised attempt to carry the matter further, or even to try to reduce the numbers of flies in places where the disease has occurred in epidemic form. The reasoning brought against these discoveries is quite insufficient to stop work on the subject. Because the epidemic died out before the infected flies, which had become sleepy and sluggish in the cold, the possibility of the flies being carriers must be denied, they say; and because infected flies were found without the human disease being found, therefore it is supposed that the two have no connection; and because two artificially made graphic *curves* of the numbers of flies and cases of disease did not correspond, the whole idea was said to be nonsense. But there is no reliable method of counting either flies or mosquitos in towns or districts. It is ridiculous to set aside good work for such petty reasons. We know that it is possible to find an infected mosquito without discovering any human malaria, and yellow fever frequently ends with the onset of the cold weather, when some mosquitos persist, though they have become sleepy. Yet every one agrees that mosquitos carry malaria and yellow fever, and that, indeed, these diseases are only carried by these insects.

At all events, nothing practical and on a large scale seems to have been done to deal with flies in this country, and in consequence, during the summer of 1911, which was an exceptionally warm one, house-flies bred in great multitudes, and in the early part of July the children began to sicken and die. In London the

infant mortality rose from 173 per 1,000 to 636 per 1,000; and in the Potteries the distress became so great that provisional hospitals were opened to deal with the sick children. The flies were multiplying rapidly in the slums, because the stables, ash-bins, and other insanitary places contained fermenting food for the fly-grubs, which thrived in the warmth; and the flies, when hatched, took the disease from one child to the food of another, and the increased death-rate was the result. This train of events was not confined to the cities named. The mischief went farther afield, to the country towns and villages, to the manufacturing districts, to all insanitary communities wherever flies existed and were allowed to breed. Everywhere hospital wards filled up with dying children, dispensaries were opened and kept going at full pressure, salt-water cures were advertised as new, when similar cures have been employed by medical men for many years past; a mayor and mayoress opened a provident fund to allay the misery, to provide accommodation for the sick infants, and to give them proper treatment; and all this was done to effect a cure for the babies when the prevention of the disease was at hand. Probably, had this fact been realised the children would not have been taken ill; and the cures, enlarged out-patient departments, overworked doctors and nurses would not have been required. But the public does not realise it; the few people who do know do not seem to realise the importance of their knowledge.

The excellent results obtained by Dr. Morgan and by his colleague, Dr. Ledingham, have recently been confirmed by Dr. Torrey of the Cornell University Medical College, New York. He has discovered

bacilli, identical with those described by Morgan, in the intestines of house-flies found during the summer in New York; and this bacillus is as pathogenic and as dangerous as that found by Morgan in London. There are excellent reasons, therefore, for fly-reduction. But many more might be cited. The transmission of cholera, of tuberculosis, by flies have been mentioned and make these insects doubly dangerous. It is possible also that the fly plays sometimes a similar part in the spread of leprosy and anthrax. Typhoid fever and infantile enteritis are very important to us in England, because they are diseases which do direct damage to us at home; tuberculosis is being reduced, and cholera and dysentery are affections now of other climes. The Egyptian ophthalmia is possibly conveyed by flies. So there are reasons enough for undertaking fly-reduction. It is easier and better to prevent flies and to inhibit these diseases than to kill a few insects. But before flies can be reduced in numbers something must be known of where they breed and how they live; for until the habits of animals or insects are known it is impossible to get rid of them or even to reduce their numbers.

After this book was written news has arrived that Professor Resenau, of the Harvard Medical College, has made experiments which tend to show that the virus of infantile paralysis can be conveyed from child to child by a biting fly, *Stomoxys calcitrans*. This fly resembles the common house-fly in size and naked-eye appearance; but it differs inasmuch as it has a pointed proboscis, with which it can pierce the skin and suck blood. This fly breeds in stable-dung like the house-fly, and measures against the latter should result in the extermination of the

former as well. This biting fly is commonly known as the "stable-fly." It is very frequent in England during the summer, and bites viciously in the daytime and evening. I have found them in Egypt, South Africa, Syria, India; and in Germany and Switzerland they are very common and annoying. The measures advised in this book should lead to their rapid reduction, and then perhaps the disease they convey will be reduced also.

## CHAPTER II

### THE FLY-EGG, THE LARVA, AND THE CHRYSALIS

John Ruskin described the fly as "the queen of the air." Had he realised her mode of life and the work she does, he would in all probability have altered his opinion of her. The house-fly is more aptly described as the queen of the dung-heap. There is one thing which the fly dislikes more than others—it is cleanliness; for, as will be seen from the way in which the house-fly spends her existence, she prefers those places where insanitary conditions abound. The domestic fly belongs to the Order of insects known as Diptera, or two-winged insects. Its metamorphosis is complete; that is, it passes through the stages of egg, larva or maggot, pupa or chrysalis or cocoon, to reach the perfect flying insect or *imago* which we know so well. In order to understand perfectly the habits of flies, these stages of its metamorphosis must be described.

The female fly prefers to lay her eggs where her young, when hatched, will thrive. Like the female mosquito, the maternal instinct drives the mother-fly to choose the place where her young will find the most suitable food. And in the case of the fly the place preferred is on or near horse-dung. This is the site of election and this is the reason why flies so commonly swarm in and about stables, loose-boxes, and slaughter-houses. Here the flies feed and breed, and it is here

Four batches of fly-eggs.
(*After Newstead.*)

that they like to sleep and pass their lives. But should the female find no stables or manure convenient when she wishes to lay her eggs, she must search for and find the next best place for her brood of young. Then she will probably go to some human excrement in a back-yard or garden privy, or, failing to find this, she will go to a pigsty, or search out a fowl-house, or cowshed, or farmyard. In towns she will find plenty of suitable places—the gutters, the mews, the abattoirs, the blind alleys in the slums, the ash-bins, the dust-heaps, the piles of forgotten banana-skins, the offal outside bakeries and butchers' shops and stalls, the masses of manure in gasworks, the horses' "bedding" in tradesmen's stables, the chicken-runs and pigeon-lofts, and all accumulations of garbage found in many factories, yards, streets, courts, and receptacles for kitchen slops. These are the house-flies' breeding-places.

The eggs are laid in batches, little clumps in and around any putrid, fermenting, and rotting thing. Each female fly lays on the average 120 eggs at a sitting (Howard). Each egg is a small oval object about one-twentieth of an inch in length. When first laid it is white and may be distinguished easily with a hand-lens, though it can be seen by the naked eye. When we know the nature of the object searched for it is usually soon discovered, and this applies to fly-eggs in manure or refuse. A stick is useful in finding them.

The length of life in the egg stage varies with the temperature of its surroundings. In hot summer weather the eggs may hatch in eight hours from the time they were laid; but this period may be delayed, according to Professor Newstead, for four days. On a warm day, however, the egg hatches twelve hours

after it was laid by the fly, and the larva or maggot or caterpillar appears.

The process of the hatching of the fly-egg may be watched with the help of a magnifying-glass. One end of the banana-shaped egg is more pointed than the other. It is towards this pointed end that a minute split suddenly takes place. The split is continued back towards the blunter end of the egg and then the maggot slowly wriggles out. When it has freed itself completely the egg-shell collapses, shrinks slowly, and becomes brown, withered, and dry.

The fly-larva, when it first appears, is a tiny, crawling creature, a white maggot like a cheese-mite. Its head end is more pointed than the other, which is blunt. Like a caterpillar, it is composed of segments—in the case of the fly eleven in number—which separate and close when the insect moves, much as the opening and shutting of a concertina or the bending action of a lobster's tail. The head of the fly-larva has a hook above the mouth, which it uses to get its food. Underneath the maggot there are some minute hooks or claws, with which it obtains its "grasp of the situation," and these assist it to crawl from one place to another. The larva breathes through small holes in the last segment, and from these the air is conveyed by tubes to all parts of its body. A remembrance of the fact that the larva must breathe is of the greatest importance, for it enables us to drown it easily—one of the methods to be employed in organised fly-reduction.

The fly-maggot, when surrounded by plenty of food, grows rapidly in the hot weather. The rate of its development is dependent on the temperature of the surroundings, as was the egg. In the course of its

Fly-eggs greatly enlarged; one shows the segments of the fly-larva through the egg-shell.

(*After Newstead.*)

growth the fly-larva sheds its skin twice, each moult leaving the maggot larger and darker. During the third phase it becomes rounded up to form the chrysalis. The larval period lasts about five days usually; but this stage may be prolonged in cold weather, or it may be actually delayed for long periods—the caterpillar falls into a state of lethargic hibernation in the winter months. Newstead, writing about his observations in Liverpool, remarks that fly-larvæ mature quickly (five days) in a temperature between 90° and 98° Fahrenheit if they have plenty of fermenting food, but that when the temperature of their surroundings reaches 100° Fahr., they leave the hotter portions of the manure-heap and crawl to a cooler spot. I found that in Cairo flies were the most numerous about ten days after the first spring heat commenced; in a fortnight after the opening heat-wave of the summer they were a perfect pest; but as soon as the summer temperature settled down to a daily 102° Fahr. or more, the flies began to diminish in numbers again, until in August there were comparatively few—it was too hot for the larvæ. Then again as the summer waned, the flies began to increase once more, for the larvæ were no longer killed by the excessive heat. At a temperature of 54° Fahr., Newstead found that the maggots were still in the larval stages at the end of eight days. In the winter the fly-larva hibernates—its development is delayed, for the low temperature causes a state of suspended animation and the metamorphosis almost ceases to progress until the weather becomes warmer.[1]

[1] In India, Colonel Jennings, I.M.S., found that fly-larvæ will hibernate in burrows under the ground. In soft soil they can be found at a distance of one foot from the surface.

As with the domestic mosquitos, cold will delay the hatching of the egg, a prolongation of the larval stage, and hibernation of some of the adult insects. But in winter, it is only the few which survive, the fittest living through the English winter. This hibernation of insects is most interesting. Some of the *imagines* hibernate as well as the larvæ; probably the pregnant females do this more commonly. But, as Mr. Jepson has pointed out, unprotected flies disappear with the coming of frost. Those that have found for themselves cosy corners in warm houses survive, and in this way some impregnated females live through to the spring, when they go forth to lay their eggs and to start a new generation. But, like the domestic mosquito, the house-fly will proceed to lay her eggs even during an English winter if she finds herself in a regularly warmed conservatory where there is a sufficiency of food for her young; and then the life of the larva depends upon the temperature. Mr. Jepson has succeeded in keeping flies alive in captivity for eleven weeks in winter; so the hibernation of the adult insect is certain and that of the larva and chrysalis probable.

After the fly-maggot has moulted twice and has grown from two millimetres ($\frac{1}{12}$ inch) in length at birth to six millimetres ($\frac{1}{4}$ inch), it passes into the pupa, nymph, cocoon, or chrysalis stage. The larva contracts within its own skin, which forms a sort of mummy-case for it. The maggot curls itself up within this case, which becomes bean-shaped. The skin is white at first, but as the insect inside contracts and the air gains access in between, its colour changes, becoming darker until the pupa is brown. One sees small groups or clumps of brown bean-like objects lying motionless amongst the straw of

a horse's bedding, or appearing in small clusters in the corners of the manure-heap. Inside the pupa-shell, the gradually maturing *imago* has withdrawn itself into a tiny rolled oval body ; and this body develops six legs, two wings, a head separated from the thorax by a short neck, all packed within the chrysalis-case, but sheathed by a protecting membrane like the mummy-clothes. Thus the chrysalis remains for five days, taking no food, but occupying the whole time in changing from a maggot to a fly. This pupa-stage may be delayed for several days according to the temperature, like the other stages of the metamorphosis. Howard states that the average pupa-life is five days, but Newstead gives the period as from five days to seven days where there is heat produced by the fermentation of the manure surroundings ; while the period may be prolonged to fourteen, twenty-eight, or even more days when the weather is cold. So the fly may be said to be affected by the climate in all stages of its life, and will hibernate during all or any period of its metamorphosis or during its subsequent career if the weather is cold. But when the spring is come and summer advancing, hibernation ceases and its life begins.

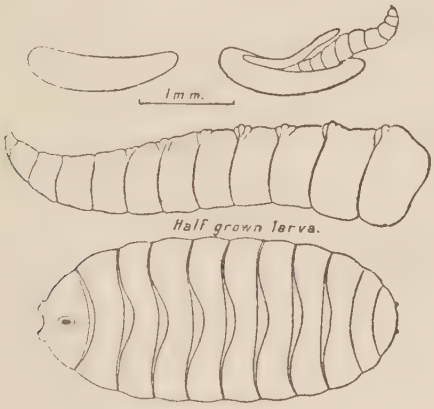
Within the brown barrel-shaped mummy-case or shell (*puparium*) the perfect fly is formed. The head, with its two compound eyes, develops inside the *puparium*. Between and in front of the eyes there appears a membranous bag or sac which the fly can inflate at will. According to Hewitt, when the time has come for the perfect insect to emerge from the chrysalis, this bag is inflated and the inflation bursts the pupa-case. A circular split occurs in the shell, and the fly pushes itself out from within. First the head, with its antennæ, proboscis, and eyes, is protruded ; then the forelegs are

thrust out; and slowly the flying insect is born—like the delivery of an aeroplane from its hangar—to live its life of freedom. The full-grown fly leaves its old home —the pupa-case with its mummy-clothes—to take care of itself, and it pushes, walks, or crawls away from its former surroundings. If it encounters obstacles it pushes its way through them by simply inflating the bag in front of its head; or by alternately inflating and deflating the sac, it bores its way through the soft manure bed. But usually the larva is wise enough to enter the chrysalis stage at the edge of the manure-heap, for it foresees possible difficulties of this nature, and then the use of the bag after birth is not required. But nevertheless this bag is being constantly tried in case of eventualities. Arrived at the edge of the wood, the home where the early life was passed, the fly tries its wings. These have been closed over the back of the body but kept separated from each other. Now they are opened and shut and soon grow harder and stronger. The insect then cleans its legs by rubbing them together or by stroking the forelegs with the hind ones; and at last opening its wings wide, the house-fly sails away on the wind in search of food and adventure.

From the foregoing, it will be realised that the best time to undertake fly-reduction is during these stages of fly-life which are known as the larval metamorphosis. The flies are then congregated in clumps and clusters,[1] they are crawling maggots living together in hundreds and perhaps thousands within a small area, and these maggots or grubs can be seen easily, cannot escape, and may be destroyed in large numbers. On the other

[1] It has been estimated that one female fly can produce in one month 506,250,000 offspring. Supposing only half of these survive the larval stages, we have the enormous total of 250,000,000 increase per month.

hand, the total numbers of the flying insects which can be caught and killed is very small compared with the numbers of larvæ which can be dealt with. It is of little use trying to kill flying wasps, mosquitos, or flies ; the amount of killing we can do will not seriously affect the total numbers of these insects. They should be attacked when they are crawling, wingless creatures, and they should be dealt with in their lairs, where the grubs can be found in enormous numbers. In this way only can flies be reduced satisfactorily. It requires organisation and perseverance, but it is well worth these, for lives will thus be saved.




Fly-eggs, larvæ, and pupa.
(*After Martin.*)

The pupa taken from inside the pupa-case.
(*After Howard.*)

## CHAPTER III

### THE LIFE AND HABITS OF DOMESTIC FLIES

In warm summer weather the larval metamorphosis of the house-fly requires at least ten days ; and, as stated before, this period may be prolonged by variations of temperature. During the larval stages the fly-grubs and pupæ are much exposed to external influences, and the maggots are more readily killed—from the fly's point of view this is its most dangerous age.

But once the fly has passed through its difficult youth, and when the *imago*, the winged insect, is safely born, then each fly is king of his own country. He knows no laws or conventions, he can go where he likes and feed where he likes, and the females of the species can do the same. The fly is ruled by one thing—the temperature. Otherwise, its life is one of almost unalloyed happiness. It is free to roam, to feed, to sleep, and to perpetuate the species. The winged domestic flies have enemies, it is true ; but these are uncommon when we consider the numbers of flies that there are. Hers is a giddy life while it lasts, but the winter comes with death in its train ; and whatever the fly has to do must be done quickly. The queen of the air is therefore quick at her work, but she does it well. Nature has arranged that she shall be born from the chrysalis fully equipped for her dangerous traffic with life and death ; and Nature has perfected the implements with which

the fly carries disease. Once the fly has "arrived" no time is wasted.

The domestic fly is a strong, stout, bristly, hairy, two-winged, six-legged, flying insect. Some flies are larger than others. This is because, probably, the food which the larva received was better and in more quantity in some cases than in others. Or perhaps individual size is a family matter, as it is frequently in human beings. But probably the size of each fly depends upon the size it attained during its larval stage; the chrysalis and the flying insect do not grow. Small flies never become large flies; as they are born so they remain. It is thus with many insects, but the females are commonly larger than the males, though occasionally the reverse is the case, and sometimes one sees large males *in coitu* with small females, although this is unusual.

From their disease-carrying potentials the mouth and legs and intestines of flies are important parts. The six legs are bristly and strong. Each leg has two claws, and between the claws there are soft sticky pads called *pulvilli*, with which the fly clings to seemingly impossible slippery surfaces; for there are hairs around the pads which secrete a sticky fluid. The mouth consists of a proboscis which ends in two flabby pads, which can be protruded and applied to the food. There are no teeth, but each mouth-pad has some hard ridges which can be used as rasps or saws for breaking up small hard objects in the food; the flies' saliva does the rest of the mastication. The saliva is poured out on to the sugar, and a thick paste is made. The mouth-pads are then applied, and the paste is sucked up and swallowed. Then the fly moves on and repeats the process. Some of the paste adheres to the pads and

the proboscis, and the fly then uses her front legs to clean her face. In consequence her legs become covered with the food too and with any germs it may contain, and she uses the hind legs to clean the front ones, and then they are all covered with the food and its germs. But the fly likes to live in the midst of plenty, and the more filthy the food she has sticking to her mouth and legs the better she enjoys it. The germs like it too, for the fly never has a bath. It is a grand dirty life for all concerned.

It can be readily understood how disease germs live and multiply on these sticky surfaces, entangled with the fly's food on its legs, among the hairs and bristles, as well as on the mouth-pads and proboscis. But there is no doubt that germs are swallowed by flies, and can and do multiply within the bowels of the insects. The fly's internal digestive apparatus is very simple. There is a throat winding up the proboscis, a long gullet leading to the stomach and intestines. There is also a crop connected with the gullet by a long tube; this crop is a large distensible bag where food is stored until hunger requires its digestion. According to Dr. Graham Smith, house-flies after a meal frequently regurgitate drops of fluid from their mouths, and these drops are responsible for the larger marks on the lump-sugar or on the window-pane. The smaller marks are those of excretion, fully digested by the fly and passed from the intestine, which contains an almost pure nidus for bacteria.[1] Thus are fly-specks made. Everything seems to have been disposed by a provident Nature for the germination of germs on and in house-flies. These insects can harbour and foster typhoid and cholera bacilli on their feet, on their mouths and proboscides, and inside their

[1] Bacteria have been found in dry fly-excretion for a period of six months.

crops such bacteria will thrive in the flies' food ; and then, after many hours perhaps, the germs will be regurgitated into a baby's mouth or into the invalid's beef-tea. Or the germs can multiply in the digestive processes of the fly and be passed on to the sugar, or on to the spout of the milk-jug even in a London drawing-room. Nature is so complete in her methods—she takes no risks lest her schemes shall fail ; if she desires to perpetuate a disease she leaves nothing to chance, but makes sure of every means to attain her ends ; but why she does it is difficult to explain.

The domestic fly must be possessed of some subtle sense. It has a large compound eye with which, probably, it can see in all directions, for the eye is faceted in every plane. But it must also have a peculiar power of smell. Note how flies will swarm to a kitchen, a larder, a privy, an ash-bin, a manure-heap. It is the food therein which attracts them from all quarters. But how this is done exactly is difficult to understand. The way in which a mosquito also finds her food in a house is very extraordinary. It can hardly be sight only, for she works in the dark, and can recognise the presence of living blood in a distant room ; it can hardly be the sense of smell, for where are there smell-organs in gnats or flies large enough to attract these insects to their food and to cause them to go long distances for it ? These insects must be possessed of some subtle sense which we human beings cannot realise. Their nervous mechanism must be wonderful for such senses to be contained in such small bodies. Yet the nerve ganglia of flies are small affairs. Why do some mosquitos bite only at night while others will bite in the daytime too ? Some species do the one and others do the other. A house-fly has wonderful

sight without doubt, and yet it will brave its obvious dangers to itself by persistently returning to one's nose time after time. But however acute the senses of sight and smell may be in the house-fly, both are almost completely under subjection during the night-hours. The nocturnal mosquito, on the other hand, is very wide awake. A fly will sleep on the edge of a jam-jar throughout the night even in the presence of a strong light. Yet it possesses no eyelids—its sleep must be very profound. With the early dawn, however, the fly is up and about. Its habits are the reverse of those of the mosquito, although its eyes are apparently similar to those of the blood-sucking insect. In a bedroom the house-fly is the most annoying insect imaginable. The detestable way in which it alights again and again on the sleeper's face to drink the perspiration, its irritating persistence, its hateful touch and the softness thereof, combined with the knowledge of its life and habits makes it the most loathsome of creatures. Watch the fly being born on the manure-heap. Then observe it on the edge of the milk-jug. Look at its track on the window-pane or on a sheet of clean paper. Examine its legs with a magnifying-glass and then watch it drown in a cup of hot tea. Lastly, observe the flies swarming over a ham in a restaurant or settling on the sugar-basin. Ugh ! when we know what they do it is horrid.

The length of a fly's life also varies with the atmospheric temperature. In very hot summers many of the house-flies die when the weather becomes very dry and oppressive. But when the temperature is moderate the fly's life is prolonged as it is during the larval stages. In the hottest English summers the fly's life is believed to be about three weeks only, but some observers have kept individual flies alive

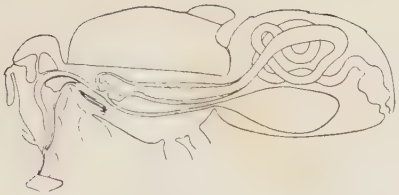
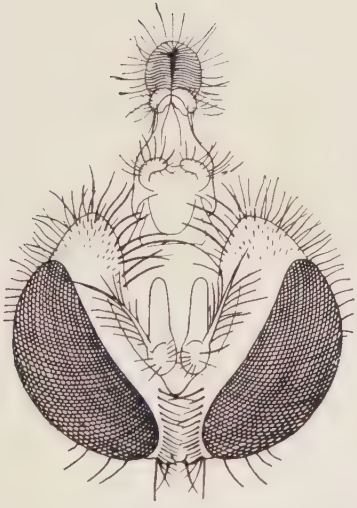


Diagram showing the digestive apparatus of the fly.
(*After Martin.*)



The head, proboscis, and mouth-parts of a house-fly (greatly enlarged).
(*After Martin.*)

even in the warmest weather for sixteen weeks. Yet very hot and very dry weather certainly does kill off a large number of flies. But then a drought will cause the rapid development of the eggs, larvæ, and nymphs, and will cause the hibernating females to lay more eggs. The length of life of individual flying insects is very difficult to determine exactly, because captivity must produce great modification in their lives ; it seems impossible to measure the lives of these insects under natural conditions.

There are certain questions concerning the life-history of these insects which require elucidation. It is most important that the normal length of life of both male and female flies should be discovered. It is also most important that the time of the occurrence of sexual maturity and mating should be learned. Much depends upon these points. Once the exact details of the natural lives of flies are fully known, the problem of fly-reduction should be much simplified. Research is required ; but research is a costly thing, requiring much patience and persistent attention to little observations and details. Information concerning flies, however, would well repay the cost of research ; for the result would be improved health. Hewitt states that flies become sexually mature ten to fourteen days after they emerge from the pupa-case ; and that four days after mating the female lays her eggs. Griffith, another observer, found that flies lay their eggs when the females are ten days old. But if the length of the summer life of the fly is only three weeks it gives but a short period for sexual maturity, although Griffith states that flies will lay fresh batches of eggs every ten days. In all probability it will be discovered that flies live much longer than is generally believed and that cage experiments are misleading.

Nuttall and Jepson have made some very careful experiments with various methods of marking flies for the purpose of identification. No method seems to be really satisfactory. The well-known work of Lord Avebury in marking bees, wasps, and ants cannot be as satisfactorily copied with flies, though Graham Smith has traced marked flies 700 yards from place of liberation. It is unfortunate, because much information might have been gained by observing marked flies. The house-fly is a powerful winged insect. It can fly stubbornly and apparently knows little of fatigue. It is wonderful how flies will accompany a fast-trotting horse. A small swarm of flies will keep pace with a four-in-hand coach as a school of dolphins will with a steamer going at full speed. Recently, on board a yacht, a house-fly sailed round the Isle of Wight and spent the time walking up and down the glass cover of the compass; it seemed quite at home in its strange surroundings. Flies will travel a long way in search of food or of a suitable place in which to lay eggs. But, like mosquitos, flies will not volitionally travel far unless they are starving or have no suitable nesting-place. Insects will not fly far merely to gratify geographical curiosity, as some people would have us suppose. If there is plenty of food near a fly-breeding place, they will not leave the vicinity of that breeding-place, and there is no reason why they should.

But, as emphasised before, more knowledge is required concerning the length of life of individual flies. It is a matter of the utmost importance. There is the possibility that flies live as long as female mosquitos. It is obviously an important matter to know how long a fly may retain disease infection and how long each infected fly can convey disease; then it might be

possible to understand how many cases of human affections any single fly can be responsible for. Such an exact knowledge would influence our methods of dealing with the pest, would determine the necessity of instituting measures against the living flying insects during epidemics of typhoid or infantile diarrhœa. At present, during heat-waves in England, the house-fly is believed to live for three weeks only, and by the time the epidemic has appeared single infected insects can have but little time to live, if the short-life theory is correct. So that, with our existing information, measures of fumigation and *imago* killing seem hardly necessary even if we could be certain of destroying the actual offenders. The destruction of larvæ is much easier and seems more promising so far as the prevention of fly-borne disease is concerned. But with patient research much more might be known about these dangerous insects than is the case at present. With the institution of fly-reduction generally more widespread interest may result in more knowledge and then perhaps these problems will become problems no longer.

## CHAPTER IV

### THE FLY'S ENEMIES

The fly has no friends; she has enemies. Her eggs are frequently eaten by fowls. The poultry which stalk about the farmyard feed gladly on fly-maggots. Watch the old hen teach her chicks to eat the fly-larvæ. It would be very disappointing for the mother-fly to realise, if she could, that her offspring instead of spreading disease among human beings had merely become food for fowls. It would be an ambition blasted in its realisation. Probably other birds also feed on fly-eggs, larvæ, and pupæ—sparrows, starlings, pigeons, ducks; but there is little certain knowledge of this. On the other hand, some species of ants undoubtedly feed on fly-maggots and nymphs. These will invade the manure-heap and soon rid it of the fly-eggs and caterpillars. Unfortunately, it is not possible to apply ants to every manure-heap, so this method of fly-reduction is not practicable; it is much easier to remove the manure-heap once a week. Most beetles avoid fly-larvæ and manure, though a few species have a partiality for both. There is a well-known beetle in South Africa and India which spends its life rolling horse-manure into balls and trundling them up and down the road; but whether such beetles eat the fly-maggots is unknown.

The enemies of the adult fly are more numerous

than those of the fly-larva or pupa. In the summer, and in hot damp climates, the servants frequently complain that they find dead flies glued to the window-panes; this is caused by a fungus disease. The bodies of such dead flies can only be removed from the glass with some trouble. It is caused by the fly becoming infected with the spore of a fungus belonging to the family Entomorphthoreæ. The spore multiplies into long microscopic threads, which push their way into the body of the fly and penetrate its tissues. The threads produce more spores, and these again more threads or *hyphæ* until the body of the fly is completely destroyed as by a canker. At the same time the *hyphæ* grow outwards and spread over the spot where the diseased fly—which has become sleepy and sluggish—happens to be, and thus the fly dies glued to its last resting-place. At Port Said, during the hot weather, the bodies of hundreds of flies destroyed by this disease are found stuck over the windows of the abattoir and the quarantine stables. This fungous affection of flies is a most interesting and may be a most important factor in fly-reduction; many experiments have been conducted and are being carried out now with a view to discovering new information concerning it, for it might conceivably be used to prevent flies; that has been suggested.[1] But even under the most favourable circumstances the numbers of flies so destroyed, even in hot climates, is small in proportion to the fly population. Without doubt, fly-reduction at present rests in destroying fly-larvæ.

There are mites which cling to flies; but it is

[1] A Report on this parasite of house-flies (*Empusca medusæ*) by Dr. Graham Smith to the Local Government Board is promised in 1913. Dr. Morgan and others have succeeded in cultivating this parasite artificially.

difficult to say whether these are friends or enemies or merely hangers-on. They have been known a long time, for, according to Howard, Dr. Geer mentioned mites attaching themselves to flies in 1755, and Linnæus wrote about them in 1758. The most common of these parasites are the cheese-mites. The mite clings to the fly and drops off on to a new cheese. Here it breeds with great rapidity in warm weather; but when it is cold its life, like that of its host, is slowed but prolonged, and so is that of the cheese. Then there are red mites, which attach themselves to flies as they do to mosquitos. They cling on between the legs of the fly. But whether they kill the flies or not is not known.

Some spiders catch flies in their nets; then they kill and eat them. But spiders, even in the most cobwebby houses, cannot account for many flies. Like the mites and ants, their share in fly-reduction is small. There are also scorpions and centipedes, lizards and chamelions, which kill flies, and rats and even dogs will catch flies; and there are some microscopic parasites, protozoa, which inhabit house-flies, namely, *Herpetomonas muscæ domesticæ*,[1] and, according to Captain Patten, another flagellate parasite, resembling the *Leishmania*, is found inside house-flies in India.

But the fly's greatest enemy is, or should be, man. Conversely, the fly is one of man's greatest enemies. The feud is one which must last as long as one or the other endures. It is an eternal war between the insects and the human beings, for Nature has ordained a vendetta between man and the most puny-looking yet one of the most powerful of his antagonists. Like all

[1] According to Colonel Jennings, I.M.S., this parasite is only found in the male flies, which is an interesting thing.

successful wars, this one must be conducted with intelligence. For centuries past we have endured flies and the disease depredations caused by them. But now we are beginning to realise their danger and how to fight that danger; and in civilised countries, at all events, the future must show the downfall of the fly; its days are numbered in human communities. How long flies will be admitted to our houses is a question of knowledge and education; and these are swayed by advertisement. The danger of flies must be realised by all and sundry, and then the danger will be removed. As stated before, until the public understands that the house-fly is a dangerous pest which can be prevented, little or nothing will be done to institute that prevention. As soon as every one begins to talk about it something will be done and that quickly. Let it be realised that we cannot hope to kill sufficient numbers of these flying insects to seriously affect their total population—even in the coldest weather. Therefore all measures must be directed to the destruction of the crawling larvæ when they are congregated together. That is the chance which Nature has given human beings to rid themselves of a pest, and the diseases which are caused by it—diseases which are killing them and their children. Take the fly-larvæ in the manure-heap and in the stable, in the slum and back-street, and destroy them. There will be fewer flies then, and so many human lives the more. It requires a little thought, a little work and care, some organisation, much perseverance, that is all—and our children will live instead of die.

## CHAPTER V

### HOW TO REDUCE FLIES

The easiest and best way to reduce the total numbers of flies in any given community is to kill the fly-larvæ when they are feeding in the manure-heap; and the easiest way to kill the larvæ is to destroy the manure-heap and all it contains. But it is not sufficient to destroy the manure once and then to allow fresh manure to collect again to harbour flies once more. The manure must be destroyed regularly once every week during the fly-breeding season. The fly metamorphosis requires at least ten days in summer weather, as stated before. Therefore it is sufficient to deal with the manure once every week in warm weather and less frequently during the colder months, for then the metamorphosis is delayed.

But flies can fly some considerable distance. Therefore it is necessary to destroy all fly-breeding places once every week. Every fly-breeding place within range of human habitations should be dealt with weekly and regularly.

At first sight this would seem to be a difficult and expensive operation, but, as a matter of fact, it is neither difficult nor expensive. Anti-mosquito campaigns carried out in this way have been undertaken in many parts of the world, and have been most successful, and their small cost fully justified by results

—improved health. Anti-fly campaigns should prove the same, for the conditions are similar, and the results to be expected should also be the same. But in England, at all events, there exists already the means of dealing with fly-breeding places regularly, for there is in every town, and in most villages, an efficient sanitary organisation; and it is in the towns and villages that there are more children, more flies, more disease. But the danger of the fly-breeding places does not seem to have been realised, and the manure in many places is not removed sufficiently regularly nor carefully. In many urban and rural districts in Great Britain there are inspectors of nuisances, and these have powers to enforce the regular and complete removal and destruction or disposal of manure, refuse, and collections of garbage which serve as fly-breeding places; and if the owners of fly-infested premises do not or cannot perform the task of fly-reduction, the local sanitary authority can be forced to do it.

But flies still exist in many towns and villages because neither the public nor the local inspectors realise their danger; and because the laws and by-laws are not therefore enforced in their entirety. The result is flies, disease, and death. But a more careful administration and a better organisation should give fewer flies, less disease, and a falling death-rate; and these at a very slightly increased cost or raising of the rates.

Just before this chapter was written, the writer had occasion to visit one of the cities of South Wales to make some inquiries concerning an infantile disease which had broken out there. One of the staff of the health office happened to mention that as the spring had been warm and dry an increase in the infantile mortality was soon to be expected. We visited some

of the slums of the town, and he entered a dairy shop to use the telephone. The shop was very clean, and the milk, cream, cheese, looked fresh and palatable, the tables and utensils were glazed and covered. But on the window-pane and on the edges of a milk-jug were ten house-flies, and on a cheese-plate were as many more—there can be little doubt about the expected increase of the mortality. At the back of that creamery there was the dairyman's stable, and here in the manure were the house-flies and some blue-bottles breeding. The manure had been removed regularly every few days, but the horses' bedding had not, for it was used over and over again; here the fly-larvæ throve.

The question arises as to the most convenient way of dealing with the horse's bedding in the stable. The owners of such horses naturally object to supply fresh bedding in the stable every week; it is very expensive, they say. Yet the tradesman has clean bedding for himself every week at least, and it seems hard on the horse that it should not be treated in the same way as his master. However, the question of expense is there. The remedy lies probably in cleansing the bedding once a week, freeing it from manure, and destroying the fly-larvæ with petroleum or chloride of lime. Once every week—a certain day should be chosen—the stables and loose-boxes should be cleaned out. The manure and refuse should be separated from the straw and disposed of as usual, in accordance with the instructions and usages of the local sanitary authority concerned; the bedding should be carefully spread out over the cobble-stones in the yard and allowed to dry thoroughly. With a pitchfork the manure can be separated, and then any fly-larvæ destroyed with a little paraffin-oil—it requires but a little—obtained from the grocer.

If this was done by every keeper of horses, cows, sheep, and goats regularly and carefully once every week—at a definite hour on a chosen day—there would be no flies, the milk and the children's food would not be contaminated, and then there would be less infant mortality.

This description sounds worthy of a sanitary Utopia; it seems more easily described than done. For example, who is going to see that the dairyman cleans his stable once a week, and who is going to see that all stable-owners do the same? Suppose they object. What then? Perhaps there are hundreds or thousands of fly-breeding places to be dealt with.

But it can be done. At Port Said the mosquito brigade dealt with 6,000 houses every week, including 400 flooded cellars, and the mosquito-breeding places were sought out and dealt with regularly once every week. As a result the mosquitos disappeared. If this can be done at Port Said it can surely be done at home. It is just as easy to deal with flies as it is with mosquitos.

This is the real work of the sanitary authority. It must be done sooner or later, so why delay? Let the medical officer give the command that flies must be abolished or so reduced in numbers that the town is almost free from them; and let him see that his command is obeyed. Then the sanitary inspectors, the inspectors of nuisances, the scavenging service will realise that a crusade against the pest is to be undertaken in earnest. An anti-fly campaign must be instituted. But it should not be left to individuals, but must be carried out at the bidding and kept up under the supervision of the local sanitary authority. It is of little use to make an intermittent and spasmodic

attack on fly-larvæ in one part of a town and to leave others, or to rid one stable of its flies while the loose-box next door is breeding the insects in myriads. There must be a general and sincere co-operation carried out under the patronage of the local district councils and at the instigation of the local authority. The assistance and sympathy of the local press, the local influential persons, the mayor and corporation, the large property owners, the clergy, the doctors, the schoolmasters, the tradesmen must be gained, and the project will go through with a will. Then it will require little or no increase in the rates—people need not be asked to pay, but to assist by refusing to allow flies to breed on their premises. If every one does his or her share the cost will be trifling and all difficulties soon overcome. This is the keynote of all sanitary success—general co-operation.

Fly-reduction requires organisation—it must be kept up regularly throughout the town. This is not a very difficult matter in urban districts. But in rural districts such organisation is not so easy. The inhabitants of villages consisting of scattered houses, farms, and labourers' cottages are less capable of concerted action. There is often only one sanitary inspector, whose duties are spread over a large area, and he is one of many similar officials under one county medical officer of health. Here private enterprise is of great service. If one landlord interests himself in the saving of child-life he can do a great deal in assisting the local authority. Let him convene a meeting of his neighbours. They can form themselves into an anti-fly association, and they can soon obtain the necessary fly-reduction in the parish by influencing their tenants among the parishioners. An important landlord can

even use pressure to make the farmers careful in the disposal of manure, can even insist on stables being regularly cleaned, and the house-refuse being burned periodically. Manure used for agricultural purposes harbours great numbers of fly-larvæ. But this is only dangerous when such manure is stacked in garden corners or in the farmyards for more than twelve consecutive days. Such manure should be completely covered up with a thin layer of earth or sand. But it must be completely covered or the fly-grubs will thrive. It is better to dig such manure directly into the ground if possible and not to allow it to rest for more than a week exposed near the houses; flies do not breed in well-tilled fields and furrows. A little paraffin thrown over a manure-heap does no harm to its properties; and if done in the morning and allowed to dry in the air it is not dangerous, for paraffin quickly loses its inflammable qualities when exposed to the air. A rural district will soon find its flies reduced in numbers if the dictum goes forth—*all manure must be disposed of regularly once a week.*

One hot summer's afternoon about twenty years ago, two students were roaming about the fields in the north of London. During the course of their rambles, they saw a village in the distance and they, being tired, walked towards it in search of refreshment. It was the village of Edgware, which in those days consisted of a street of shops, one inn, and some scattered private houses. They entered the inn coffee-room and began a meal of tea, bread-and-butter, strawberry-jam and cream—a delightful repast peculiar to England. Then came the flies; they also were particularly interested in this English repast, and they were soon fascinated by its beauties. The flies came in their tens, their hun-

dreds, their thousands, and they ate up the strawberry-jam, and they inspected the cream, and many had ecstatic but fatal baths in the milk-jug. The students had no place and they had no tea—the flies took it all.

Then ensued a discussion between the students and mine host of the hostel as to who should pay for the repast. The latter said that the students had ordered the repast and must pay, while the students maintained that the flies had taken their food. It ended in a compromise—the students paid half, the rest was put down to the flies' account. The hotel keeper remarked that he did not know where the insects came from, but that if he did——. Had he looked at his own stable-yard he would have seen multitudes of fly-grubs crawling about a smelling manure stack which had grown in size steadily for several months by the addition of daily accumulations. But the flies drove the students from Edgware.

If the public would realise what damage to health, what misery, and what a pest these disagreeable insects are there would soon be few left. It is so easy to fight them so long as the fight is carried out perseveringly and with general organisation. It is necessary to institute an anti-fly campaign wherever the insects abound. But it is a mistake to delay such an institution until the flies arrive. For then they will do their damage first and be controlled afterwards when it is too late. It is of little use to close the stable door after the horse has run away. Let us make a start at once with the anti-fly crusade.

## CHAPTER VI

### THE BEGINNING OF THE ANTI-FLY CAMPAIGN

The best organisation to conduct an anti-fly campaign is the local sanitary authority, and the best individual is the medical officer of health. But it can be started and organised by any influential person interested in the welfare of his fellows. To any one who is concerned in the problems of child-life and the common good of the human race the fly question is one of surpassing interest. It is the more important because so much can be done, lives can be saved—there can be no better aim than this.

But before the actual fly campaign can be started some inquiries must be made. The damage the flies do in any one locality must be found out if possible. Much information can be obtained from the Annual Reports of the Registrar-General, Somerset House, London, which give the causes of death in England and Wales. These state the infantile mortality, the incidence of typhoid, the prevalence of tuberculosis in the cities, towns, and in the country generally. Similar Reports are published in Scotland and Ireland, and in other civilised countries. From these Reports the necessary information may be garnered. The local medical officer of health knows still more about the local conditions, and can always supply exact figures.

The next step is to make inquiries about the chief

likely breeding-places of flies in the town or village to be dealt with. If the health officer is interested he can readily find these out. He should obtain a list of all the stables in the town. Every carriage is licensed, and perhaps the knowledge of this fact will enable a complete list of stables within the urban district to be drawn up. These are the first steps.

Next, one of the sanitary inspectors should be instructed to find out where the flies are breeding in large numbers. He should be shown some manure in which there are some fly-larvæ. He can be given a map of the district, and he must be made to examine the houses, shops, yards, street by street. He should mark on a map the exact situation of all manure-stacks, stables, cowsheds, pigsties, and then place a distinctive mark against those in which he finds the fly-maggots. This should be done, if possible, during the summer, for the warm weather is the chief fly-breeding season. It will take him some time—a period varying with his energy, and the size of the town, village, or district to be dealt with. But if necessary two or more sanitary inspectors can be told off for the job.

As soon as the fly-map is ready and complete the person directing the campaign can draw up his report. He is in possession of the figures of the infant mortality, the incidence of typhoid fever, the prevalence of tuberculosis, and now he knows the chief breeding-places of the flies which may convey these diseases. He has the facts at his fingers' ends. The report should be short and concise, clear and lucid, and technical terms must be avoided. It should be presented to the local district council which has charge of the sanitary affairs of the town, and this council should be asked to consider the

A mosquito-map of New Orleans; fly-maps should be made in the same way.
(*After Boyce.*)

question of fly-reduction. The report should contain suggestions as to the best way in which the fly-nuisance can be dealt with. If required, the necessary funds should be asked for boldly. The cause is a good one.

The question will then arise—how much money, if any, will be required to institute and to carry on the anti-fly campaign? It is not sufficient to start the work, but it must be kept up diligently and indefinitely. Fly-campaigns, like mosquito-campaigns, once started must be persevered with. It is not enough merely to reduce the flies in a neighbourhood, but the reduction must be maintained. The cost, however, will gradually diminish as the insects disappear. This has been found to be the case with mosquito-campaigns. But in England fly-reduction should be counted as an ordinary sanitary measure, and kept up as other sanitary measures are—the regular inspection of dairies, cow-sheds, and other dangerous establishments. Fly-breeding situations should be regularly inspected and as regularly dealt with as these are. Looking at fly-reduction from this point of view, no extra expense should be incurred, for there is already a sanitary organisation in this country to deal with all insanitary places; and fly-breeding grounds are insanitary places.

Each breeding-ground must be inspected and dealt with once every seven days, and the fly-maggots destroyed regularly every week. In some places this regular inspection, which should continue summer and winter, may cost money; in this case a correct estimate must be obtained. The estimate can be made in the following manner. Make a house-to-house examination of the town, and note the exact spots where the flies are breeding. This sounds a considerable undertaking, but it was done easily at Port Said, a town of

fifty thousand inhabitants. Every fly-lair must be marked on the map, and then the cost of dealing with them once every week calculated. This is not a very great undertaking, for a man who is experienced soon learns to know where to look for the fly-maggots. A map of the town can be ruled into squares of equal extent, and one man given the work of discovering the fly-lairs in each square. Let him begin at one corner of the square, and examine all the houses, street by street. He should write in a note-book the names of the streets, and the number or name of each house, and if possible the name of the proprietor. The examination should be made at the height of the fly-breeding season. In this way the exact number of fly-lairs can be discovered, and then the cost of dealing with them once every week estimated. This method of making the estimate is really not a very great undertaking, as stated before, and there is the satisfaction of knowing that it is correct, and that there will be little likelihood of the necessity for subsequent requests for further monetary grants; constant demands for supplementary credits are always a source of annoyance to administrators and councils. If necessary, the cost of dealing with the flies throughout the town once every week can be borne by the sanitary authority; in this case the cost of the labour required can be estimated as well as the extra expense of destroying the fly-larvæ, the supply of paraffin or chloride of lime, and any other requisites included. But it is better that the owners of fly-lairs should be made, if possible, to deal with their flies themselves, and the sanitary authority should content itself at first with instructing the public; if this instruction fails the sanitary authority can afterwards undertake the work of fly-

reduction at its own expense, and increase the rates if necessary.

The estimate having been obtained it can be included in the report submitted to the sanitary authority or municipal council. If the report has been wisely drawn up and brought forward tactfully it will produce but little opposition. There may be one or two dissentients, but these can be overruled by wise counsels. There is the knowledge that the anti-fly campaign is a just measure, organised to improve the public health. And the cost will be trifling. Even if the project is dismissed persevere, obtain more information concerning the incidence of fly-borne disease, write a further report, and try again. Sooner or later the project will be agreed to, and the money will be forthcoming; but in the majority of instances no increase in the sanitary budget will be required. The success of the proposals will largely depend on the influence of the individual in charge of them. If he is energetic, tactful, and wise he will succeed. If he is a man of resource the project will pass, and the anti-fly campaign will be approved of.

As soon as the proposed campaign is agreed to there need be no further delay. The next step is advertisement. This is the age of advertisement, and very few projects succeed nowadays without it. The sympathy and assistance of the local press should be obtained. If necessary, publish a summary of the report. Or write letters to the editors stating the importance of a fly-campaign, the prevalence of fly-borne disease, and the probable effects of the former on the latter. Let there be no hesitation about this. State the facts boldly and lucidly. Point out that the children are dying unnecessarily; that some of the

typhoid can be prevented. This should prove to be good *copy* for the newspapers. In some places, notably in the United States, there is already a "Kill that fly" campaign. This is good so far as it goes. But though we may kill a few flies in our houses, on our window-panes, our neighbour's flies will still appear and will annoy us as before; for such a killing of flies will not seriously affect their total population. Whereas we can prevent the birth of thousands of flies by simply cleaning our stables regularly. A successful crusade against fly-larvæ is undoubtedly the best measure, and this can be effected by advertisement. Write about it and talk about it. Moreover, get others to write about it and to talk about it too. And throughout the progress of the campaign periodical advertising is necessary to keep public interest from flagging. Intelligent general public interest paves the road to success in all health matters. This should always be remembered. Therefore anti-fly campaigns, like anti-mosquito campaigns, require perseverance and again perseverance.

In the United States, advertising posters have been made use of to bring the dangers of flies to the public notice. Whether such are necessary in this country must be left to the discretion of the individual conducting the campaign. Advertising is carried out differently in different countries, and every method must be considered and weighed in the balance according to local conditions and requirements.

In the meantime, while these preliminaries are taking place, the more exact the knowledge of the fly-lairs in the town the easier it will be to get rid of them and the less the cost. The sanitary inspectors will have complete lists of the fly-infested places, and they can

soon compile a fly-directory. Incidentally they will learn more about the sanitary conditions of the several wards or districts than they knew before. A fly-campaign therefore has other results besides the reduction of flies. It is productive of a more intimate knowledge of local conditions; insanitary workshops, backyards, lavatories, wash-houses, cowsheds, pigsties, factories, etc. will come to light, and under the control of the sanitary authority. There can be no better sanitary measure than this.

## CHAPTER VII

### EARLY FLY-REDUCTION

As soon as the nature of the campaign has been advertised, operations can be begun. The start can be made in the summer or during the winter as convenient. The chief fly-breeding places are known, and it remains to deal with them. Every fly-lair should be cleansed regularly once every week, and it is important to make this a routine; to this end each fly-lair must be inspected by an official of the authority conducting the fly-campaign once every week. The methods employed at Port Said, Ismailia, Panama, Port Swettenham, Havana, and many other places for the reduction of mosquitos should be copied exactly for the reduction of flies. The town or district should be mapped out into equal areas—one for each day of the week, excluding Sundays. Beginning on the Monday morning, the inspector should traverse the area allotted for that day, street by street, and he must examine every fly-lair for fly-maggots. He should arrange to visit each fly-lair at a certain definite hour on the day allotted to that area; then the owners and their servants will know when to expect him and will have the premises clean for his coming. In this way the fly-larvæ will be destroyed at a certain hour of a certain day every week throughout the year. The owners of the fly-lairs will learn to expect the fly-inspector, and this

Mass of fly-pupæ (cocoons) in stable-manure (natural size).
*(After Newstead.)*

will make them careful—they will soon find it worth their while to have the offending manure removed rather than to incur his displeasure ; and if the owners are well versed in the nature and the usefulness of the campaign they will assist the inspector in his duties.

At first the inspector may meet with opposition. But if there is a popular movement in favour of fly-reduction, all opposition will soon disappear. The extent of the popular movement depends upon the extent of the advertisement. That is why advertisement is so important.

Whenever the fly-inspectors find fly-maggots they must report the fact to the proprietor or person in charge of the premises and ask him to have the nuisance abated. The owner of the stables should be instructed to remove the material in which the flies are breeding and he should be told how to dispose of it. Every city has its means of refuse disposal, and this should be utilised for fly-larva destruction.

At first, however, the inspectors should content themselves with merely pointing out the fly-larvæ to the owners of the nuisance ; they should also dwell on the dangers of flies and inform the stablemen how the refuse can be removed and the best means of dealing with it. Any new fly-lairs which are found during the weekly examination—and the inspectors should always be on the look-out for new breeding-places—must be noted and marked on the fly-map. In this way there will be a complete knowledge of the fly-distribution and the insects' population will soon be under control. But at first no attempt should be made to threaten the proprietors with legal proceedings ; persuasion must be used always rather than force. In civilised countries the people will soon realise that fly-

reduction is a beneficial measure and, knowing this, will help. But in foreign lands, where the poorer class natives are uneducated, there may be opposition at first. Even then it is better to persuade than to force. But if oft-repeated persuasion fails, then, as a last resort, the law must be appealed to, and such sanitary by-laws as exist must be brought into action. However, this must always be delayed as long as possible. Much depends upon the ability and tactfulness of the inspectors. They should be honest and reliable men who live and are known in the town. They should not be changed frequently. The idea is that each fly-inspector should become known and respected in the district in which he works, and his purpose and duties understood by the inhabitants. Therefore good men should be selected at the outset and their services retained.

The fly-inspector should report progress once every week to the health-officer or whoever has charge of the fly-campaign. They must inform of their failures as well as of their successes. They must exhibit their notebooks and fly-maps, and they must state their difficulties and the steps they have taken to overcome them. Some of them may report that they have found certain houses fly-infested but that they are unable to find the fly-larvæ. The health-officer must then institute a search for the fly-larvæ. If the search is thorough and persevered in the fly-maggots will soon be found. Usually the fly-lair will be discovered in or near the infected premises. The fly-lairs can always be found if sought for diligently. Flies sometimes travel some considerable distance; but if they are present in great numbers in one spot their breeding-place is not far off. This is a point which is well to remember.

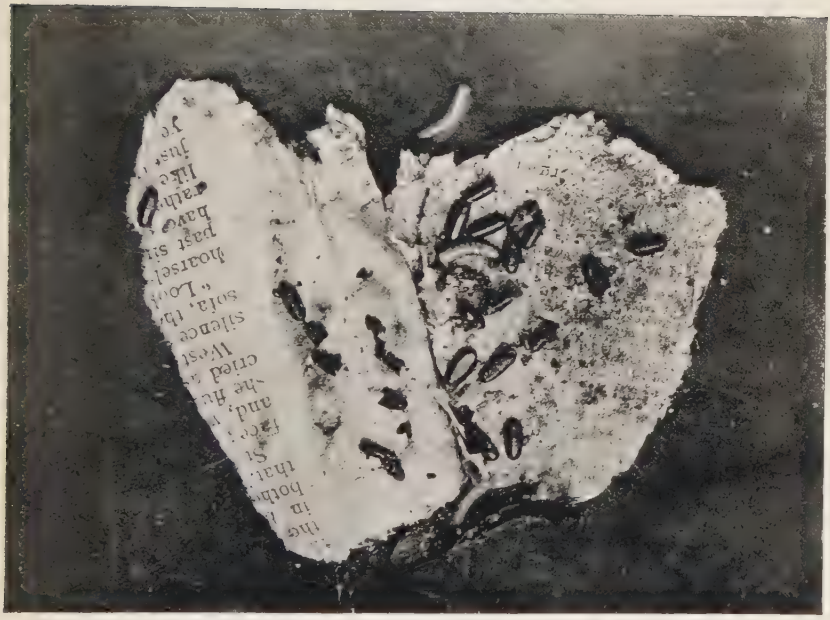
Should the inspectors report that certain stable-owners refuse to comply with their instructions, the health-officer can deal with them in the following way. He should interview these offenders against the public health, and should try to persuade them to mend their ways. If this has no effect he can write to them officially and warn them. It is best to use every means of cajolery before resorting to the arm of the law. Legal procedure, even in England, is an expensive, troublesome, and unpopular affair, and the fly-campaign will suffer, will fall into disrepute, if its name is constantly appearing in the law reports. Should it become absolutely necessary, an example can be made in a case refractory to all other means—but only as a last resource. The fly-campaign is best carried on with the support of the public; it must not be burdened with the weight of public opposition.

Once started, the campaign's progress will depend on the energy of the inspectors and the perseverance of its organisers. Each fly-lair will be regularly inspected once every week. Manure will be regularly destroyed, refuse regularly removed, and new breeding-places of flies will soon come to light. These can be examined and brought under the influence of sanitation.

If for any reason it is found that certain proprietors of habitual fly-lairs are unable to deal regularly with the fly-larvæ, the sanitary authority can help him. The manure or refuse must be removed and destroyed. Suppose that a stableman objects to this removal because he uses the maggot-infected straw as horses' bedding, he should then be made to rake out the offending material once every week, to dry it thoroughly, and then to destroy the fly-grubs with petroleum or other disinfectant or even drown them in water. In

some towns, the organiser of the fly-campaign may consider it more convenient to have a permanent gang of labourers under each fly-inspector to destroy fly-larvæ, as is now done in the case of mosquitos. These gangs would then constitute *fly-brigades*, and they can be managed in exactly the same way as described in "The Reduction of Domestic Mosquitos." But in civilised countries, at any rate, it is much better to educate the people themselves to undertake anti-fly measures. The townsfolk will soon become alive to the danger of these insects, and will know how to prevent them.

Once a year a report should be furnished to the sanitary authority by the organisers of the anti-fly campaign in which is related the progress made. These reports should be a continuation of the original memorial submitted when the campaign was started. It should contain lists of the fly-breeding places, and comparisons must be made between now and then; the number of actual fly-lairs mentioned in the progress report can be compared with the number mentioned in the first report. Thus a rough calculation of the fly-reduction can be made and reported. Suppose that there were 1,000 fly-lairs found within a certain area at the outset of the campaign, and this number was reduced by half after one year's progress, then a certain advance has been made. The annual reports can also give details of the fly-borne disease-incidence. State the facts. It may require years of continuous fly-reduction to reduce the disease-incidence so obviously as to show clearly in the returns; and even if there is an apparent increase of disease at first the campaign must be persevered with. For only in large populations where there is a con-



**Fly-larvæ and pupæ on waste-paper in ash-pit refuse ; a common fly-lair (natural size).**

*(After Newstead.)*

siderable amount of fly-borne disease will the apparent reduction of the latter be immediate, and then only if the fly-reduction is considerable. Otherwise the results of the campaign may be slow but they will be sure. The reports should also contain details of the measures taken to deal with the fly-maggots—this will be a useful example to others; and any difficulties encountered should also be set down at length with the manner of their overcoming—if they have been overcome. But publicity is everything, and the greater the publicity the better. Let the reports be printed and published and sent to the press, and endeavours should be made to obtain fair comment. If any money has been spent on the campaign, properly audited accounts should also be published. Money set aside for an anti-fly campaign should be kept in separate accounts if any specially voted sums have been spent. But as stated before, no new or special credits should be required at first under ordinary circumstances. The annual reports must contain all details, so that others may learn from the experiences gained.

Careful observations on the effects of fly-reduction will be well repaid. They may result in matters of considerable interest and importance being brought to light. Thus at Cairo, during the spring of 1909, there was an interesting repetition of history, and a recurrence of some of the Plagues of Egypt as already mentioned in the Introduction. February and March that year had been unusually cold for Egypt, but on April 24 heavy rains occurred—an uncommon occurrence in that generally rainless climate. The summer was ushered in by a heat-wave on May 1, and the temperature rose to 102° Fahr. in the shade. Fourteen days later a plague of house-flies appeared in the city owing to the quantities of damp, rain-sodden manure

that the streets, stables, Eastern courtyards contain in that filthy town, which is in a most insanitary condition. The flies bred in myriads, and the houses were soon swarming with these pests. Everybody complained, Europeans and natives alike. Food was made black with the insects, milk was contaminated, and fruit was infested with *Musca domestica*, and allied species of flies. Never before had such a plague of flies been seen by living people, not even in South Africa during the Boer War. Then began the illness and death of the newly born children. On all sides were the cries of Rachel weeping for her innocents. The *general* death-rate rose. During one week in May it reached the truly terrible maximum of 105 per 1,000. The infant mortality rose too and passed all bounds, and in two months 3,000 children under five years of age had died of enteritis. No doubt, flies conveyed the germs of this disease from one child to the food of others, and these, once infected, died within a few hours. It was impossible for the doctors and nurses to attend to these hundreds of sick children, though they did their utmost. The hospitals, the dispensaries, and the Lady Cromer charities were worked at full pressure, but still the infants died. Had there been an anti-fly campaign at Cairo many of those valuable lives—and children's lives are most valuable to the community—would have been saved. Here is a disease which is preventable. There is no doubt that with proper sanitation flies can be reduced enormously. Had Cairo been a sanitary city the fly-plague would not have occurred. Had the street and stable manure been properly removed and destroyed the flies would not have existed, and many of those children would still be alive.

But Cairo does not stand alone as a city with a

reducible mortality. Almost all towns in warm climates have excessive infant and adult death-rates. This is always due to unnecessary disease and is only due to atmospheric temperature indirectly ; the heat favours insanitation, and this causes the heavy death-toll. But as stated before, flies are a sign of insanitation and their numbers a measure of that insanitation. Even London—the capital of the most sanitary country in the world—has periodical outbreaks of disease which might be prevented. During the abnormally hot summer of 1911 there was a heavy loss of infant life in London, and the cause was the same as that which did so much damage in Cairo two years before and as it had done some three thousand years before. In London during the week ending July 29, 1911, the infant mortality rose from 173 to 303 per 1,000 infants born, and later this death-rate rose further to 636. There was a great increase of flies and fly-borne disease, and this was the result. But what a pity! We are constantly hearing complaints of our falling birth-rate, yet we calmly allow the children already born to die unnecessarily. It seems so paradoxical in the light of our present knowledge. In London, of course, the high death-rate was confined to the poorer and dirtier quarters, for in the better residential neighbourhoods the fly-breeding places have almost disappeared. In the West End the horse is going and he is taking his flies with him. King Petrol has come, and he has replaced the horse by a reciprocating engine and the stables have become garages. As a result, in richer London the death-rate increases but slightly during the heat-waves. But in the slums, the stables, the manure, the refuse remain, and so do the flies, and there death takes his unnecessary toll.

Fly-reduction entails a careful, weekly, sanitary inspection at a very small cost and in a very good cause. The result will be the saving of life. What better aim can there be than this? The existence of healthy child-life is the very backbone of the State. A well-known lady, a prominent suffragist, recently asked, "Why are you so desirous of saving these children's lives? Surely there are already too many people in the world." But her contention is wrong. As I have stated elsewhere, each healthy child is a financial asset to the State. The question of public health is one of finance. The credit which a State can command varies directly with the amount of work done in it, that is, it is dependent upon its industrial output. But the industrial output varies directly with the numbers of the inhabitants and their ability to work; and the numbers and ability to work vary directly with their health. Therefore the credit of the State varies with the health of its inhabitants, and it is the health and numbers of the coming generations which will affect the progress of the community. Child-life, public health—these are matters of high finance.

It is the duty of every citizen to save life. In civilised countries the birth-rate is falling[1]—that is one of the penalties of civilisation. It can be counteracted in some degree by reducing the death-rate. One of the ways in which this can be done is to reduce the causes of diseases. Fly-reduction will do this, and fly-reduction requires efficient sanitation.

[1] It has been reported that in France during the first half of the year 1911 the total number of deaths exceeded the total number of births by 18,000. This is a very serious state of affairs. England, America, Germany, are beginning to tell the same story.

## CHAPTER VIII

### THE ORGANISED ANTI-FLY CAMPAIGN

In the preceding chapters the beginning of the anti-fly campaign has been described. It remains to place the crusade on a permanent footing, to convert it into a routine sanitary measure, and to continue it as an established organisation for the prevention of disease. The fly-inspectors will have compiled a complete fly-directory and will have considerably reduced the total number of fly-lairs and also the total number of flies. Incidentally, the public has become educated to the necessity of fly-reduction and will be in a receptive mood for more complete measures for the permanent reduction of flies and the diseases they carry. The fly-inspectors should be given assistance and their labours extended farther afield. At first two men should be appointed under each inspector. These men should be recruited from the permanent scavenging service, and thus each district of the anti-fly campaign will be served by a permanent gang consisting of one inspector and two workmen. These men must be under the orders of the inspectors and must assist them in carrying out the work. Each fly-gang should be supplied with a cart for the removal of rubbish, manure, refuse, etc. A hand-cart is useful at first, but if necessary, and if funds will admit, a horse-drawn cart is more serviceable. The weekly inspection will go on as before, but

now the inspectors will be in a position to deal directly with the fly-lairs, and each will be able to assure himself that the fly-grubs are destroyed by actually seeing the work done under his own direction. When the inspector finds a fly-lair which has not been properly dealt with he can order his men to do it, and he can see that it is done thoroughly.

This is how anti-mosquito campaigns are now conducted in warm climates; and they have proved most successful. For not only have they been the means of supplying a complete sanitary organisation, but also a regular, weekly, executive sanitary service capable of converting insanitary conditions into healthy places. Anti-fly campaigns should be conducted on exactly similar lines. So far, the fly-campaign has consisted of a little work and much instruction, but the time arrives when more work can be undertaken advantageously, for the public will be educated to its needs. In places where there is a large ignorant native population, it is usually essential for the anti-mosquito or anti-fly campaign organisers to start at once with gangs of workmen, who must tackle the problem of fly-reduction themselves, for ignorant people will not undertake the work even in their own houses. At home, it is best to begin slowly in the manner described heretofore, and to teach the inhabitants to prevent fly-lairs themselves; then the lessons learned will be more lasting. When the idea is firmly rooted in the public mind more active sanitary measures of a permanent nature can be instituted.

The fly-inspectors with their workmen must continue their daily *beats* of inspection indefinitely. It will be astonishing to find the insanitary conditions which prevail. Once every week the whole dis-

Fly-larvæ and pupæ in old rags taken from an ash-bin (natural size).
(*After Newstead.*)

trict will come under the influence of executive sanitation, and organised fly-reduction will become an established fact. At the same time an exact knowledge of many insanitary places will be forthcoming. Besides, there will be a trained organisation to deal with such places as they are found.

But the inspectors and their workmen must be careful and tactful. If the proprietor of a fly-lair or other insanitary place is willing to put his house in order, and agrees to undertake reforms himself, he should be encouraged to do so; but he must be made to do the work thoroughly and properly. The half-hearted cleansing of a premises is only half-hearted sanitation. But the officials need not be officious. The gangs will visit every house at a certain hour of a certain day every week. Each house will have its time of inspection once every week. Then the courtyards will be cleaned out, scoured, examined, and made healthy and wholesome. This is true sanitation. The houses themselves will come under the influence. Modern hygiene is learning that it is not sufficient to build cities and towns architecturally beautiful directed by elaborate town-planning schemes; but it is necessary also that each individual house is clean inside as well as outside, and to insist that the sanitary condition of the interior is as important as the exterior. The whitewashing of a wall, the throwing of a disinfectant down a drain, is not enough. Disease foci must be laid bare, not covered up and hidden. The duties of the anti-fly inspectors are to consist of finding out disease foci, exposing them to view, and then to remove them or to render them harmless. This is their work. If the gangs of workmen such as here described were appointed to inspect the back-streets of Lambeth and Bermondsey, what

prodigies of insanitation would come to light; and the benefit of such a regular inspection would be immeasurable, if at the same time the men could assist tenants in putting and keeping the premises in order and making them proper and clean. The health-officer who organises and succeeds in such work can be justly regarded as a true philanthropist. If every house, every courtyard, every slum in the East End of London, in Liverpool, Manchester, the Potteries, Birmingham, and other large cities could be visited, inspected, and reported upon once every week by an inspector and two labourers armed with brooms, spades, a hand-cart, and advice, a difference would soon be forthcoming. It is astonishing what an amount of filthy rubbish accumulates in such places, and such rubbish harbours flies, fleas, bugs, and with these disease. Tropical medicine, which has made such great strides during the past few years, has shown that insects play an important rôle in the transmission of disease; and that such diseases are best prevented by preventing these harmful insects—malaria, yellow fever, plague, dengue, elephantiasis, relapsing fever, sleeping-sickness, are all insect-borne; and these can be abolished by abolishing the insects concerned. The question of insect prevention is a question of sanitation; and sanitation is best accomplished in the manner described.

But the inspectors and their workmen must be honest. If they are accused of petty pilfering the whole project will fall into the abyss of disrepute, and sanitation will be retarded instead of advanced. Good honest men should be chosen at the outset and their services retained. Men having families residing in the neighbourhood should be procured if possible. The possibility of dishonesty amongst the men composing

mosquito-brigades has been brought forward again and again as a factor against the institution of such campaigns. It was feared that they would improperly demand payment for their services, would insist upon receiving *backsheesh* from the poorer inhabitants, and if they did not receive such payments they might report adversely on the premises of the refusers, or they might even resort to the methods of the blackmailer. But experience has shown, even in countries where native workmen are employed, that such fears are not realised. If the anti-fly campaign has been started on the lines laid down and properly advertised, and its nature and objects fully explained, the men will not—indeed cannot—become dishonest. If a black-sheep happens to be employed his first covert act will find him out. Everybody in the district concerned will know who the men are, that they are employed to reduce flies and disease, and that their work is under an organisation officially conducted and controlled. Even the poorest classes will soon learn to respect them and to understand their objects and methods. They will become known as the emissaries of the sanitary authority and treated as such. These men will act as intermediaries between the sanitary authority and the people, and will bring the former into closer touch with the latter. At the present time the sanitary authority is, in the eyes of the man in the street, regarded as a pompous individual who sits in an office at the town-hall, is rarely seen or heard of, and who spends his time writing elaborate reports which are rarely read and still more rarely understood.

The organised anti-fly campaign will cost money. Well, ask for the money boldly! If the matter is deferred, wait a little, and ask again. Continue this policy—it costs nothing to ask. After the early fly-

campaign has been instituted as described in Chapter VI. and continued for some little time, the estimate of the cost of the organised anti-fly campaign can easily be obtained. The cost of daily wages of two labourers for each fly-inspector, the buying and upkeep of hand-carts, brooms, pitchforks, shovels—these are small matters when the health of the community is at stake. But if the work has already given good results and is continuing well, the request for funds for its expansion will not be refused for long. If there is a refusal the plea will be one of economy—a plea that will soon be overcome if the public has been taught to realise the importance of flies as carriers of disease. But there is also an opportunity of improving the general sanitation of the town by a simple increase in the anti-fly organisation at a very small cost; and reasonable people will soon acquiesce in the demand for a small annual outlay if they can be made to see this side of the argument. Of course, if a considerable sum of money is demanded for reducing flies without an initial investigation or inquiry into the prevalence of flies or fly-borne disease, the whole project may be threatened with ridicule and doomed to failure. If, however, the measures against flies are begun carefully and cautiously as described, and then, when successful, they are extended and expanded, the organisers will receive their meed of praise and the credit due to them as pioneers of a reform instituted to save human life.

Should the local council or authority to whom the demand has been made refuse the application finally, recourse to public subscription is justifiable. But it has been found by experience that the upkeep of permanent sanitary reforms requiring an annual outlay by voluntary subscription is a most unsatisfactory

proceeding. The public mind has its moments of enthusiasm similar to that of the individual, but it becomes easily tired and forgetful. It may be an easy matter for one philanthropist or one conscientious worker to raise sufficient funds to start an anti-fly campaign in one town ; but after the lapse of a few years he may pass on to other places or other pursuits, and then the project is in danger of disappearing. Or a town may be cleansed of flies in this way, and a new generation will spring up which knows not flies and their depredations, and it will forget to subscribe, it will doubt the necessity, and will refuse to pay ; the good work will cease and the flies will surely return. But if public subscription is the only course which can be adopted it is best carried out as follows. Advertise that the fly-campaign has arrived at a stage where its sphere of influence can be extended. Write to the press, giving the history of the measures which have already been adopted for the reduction of flies. State the results obtained, and give details of the extent of the operations suggested. Institute public lectures, distribute printed bills describing these points. Talk about it, write about it, and ask others to do the same. Then open a subscription list. If possible, ask the mayor, the members of the corporation, the bankers, the postmaster, and others to assist. The doors of Charity should be easily opened for such a good cause. Interest the employers of labour, the large trading houses, the doctors, the local exploiting companies, and all likely subscribers. But let careful accounts be kept of the money subscribed. Balance sheets must be published regularly and sent to all subscribers.

But fly-reduction by public subscription is a course that is not advised unless it is impossible to continue

the work in any other way. It should be regarded as a last resort. The amount of money required is so small that the local authority will supply it if appealed to in the right manner. Even in semi-civilised tropical countries there has rarely been any difficulty in obtaining funds for these important sanitary campaigns when the projects have been brought forward in a sincere and sensible way. People are beginning to realise that commercial prosperity and the public health are closely related, and communities dislike disease in their midst; but it must be shown that such disease exists. This can only be done by the publication of accurate statistics. And if the local authorities can be promised a return, or even a likely return for their outlay, they will soon acquiesce in the demand.

Probably no better instance of the beneficial results of insect-reduction and the abolition of insect-borne disease could be quoted than that of the Panama Canal zone, which at the moment of writing is much before the public. The history of that great undertaking is the history of its sanitation, a permanent monument to the victory of knowledge over ignorance. It is within the memory of most of us—this story of Panama. How the disastrous exploit of the French under the leadership of Ferdinand de Lesseps, the hero of the Suez Canal, ended in failure, catastrophe, ruin; that project of uniting the Atlantic and the Pacific oceans ended unsuccessfully because no one knew how to combat the disease which racked the Isthmus. Then came discovery, and when the Americans undertook the task of engineering the Canal, their first step was to render the zone healthy, to apply the discoveries of science, to reduce the disease-bearing insects, and as a result the project has now succeeded. Panama to-day

has a death-rate of five less than New York, and the Isthmus, although situated in one of the hottest climates, is free, and is kept free, from those diseases which caused the downfall of the French exploit not twenty years ago. In the face of such facts it is not possible to believe that any civilised community could refuse for long to undertake and continue an organised campaign against disease when there is such a powerful example before it. The general mosquito-reduction at Port Said, which is a town of 50,000 people, costs less than £1,000 per annum. Fly-reduction will cost much less than this.

But too often the prevention of disease is left in the hands of Charity, and the leaving is immoral and wrong. The prevention of disease is the duty of the executive.

## CHAPTER IX

### OPPOSITION

If one examines the lives of the world's greatest pioneers, whether it is in the direction of religion, science, the arts, civilisation, exploration, war, almost invariably the same story of opposition is told. All sincere work encounters difficulties, and one of the greatest of its difficulties is opposition; sanitary work is no exception to the rule. But at the same time, it must be remembered that if there were no difficulties to surmount we should probably hear but little of some of our pioneers. Difficulties in some form or another are sure to be met with in fly-campaigns sooner or later, and it is better to be forewarned about them. The institution of anti-mosquito campaigns has led to difficulties often of the most peculiar nature. Opposition owing to the ignorance of the population was always held up as a dark cloud hovering over the heads of the instigators. All sorts of dire effects of popular ignorance were anticipated—riots, battles with police, religious storms, handles to socialism, etc. But these have not occurred yet, although anti-mosquito campaigns have been in progress in various places in all quarters of the globe, and among various nationalities and peoples all the world over for the past ten years. Even at Port Said—which was commonly known as a sink of iniquity—never so much as a threat was received from

the people, although the mosquito-inspectors and their workmen entered every house in the town once every week to destroy mosquito-larvæ. On the other hand, opposition was encountered, and from the most unexpected sources. It came from the highly educated and believed-intelligent officials whose duty it was to further the progress of health in a community notorious for its filth and disease. They began their opposition early. First they said that the work was unnecessary. Then they said that it could not be done; that the moment was unpropitious; that riots would be caused; and that they could not undertake the responsibility of incurring the displeasure of the powers that be. Then they said that there was no money. This was at the beginning.

But these difficulties were overcome. A Company possessing great local interests was appealed to, and it found the necessary funds at once. Then the officials, fearing that the Company would obtain too much power in the place, were forced to subscribe too, and this made them angry—but the work was started. It progressed, it flourished, it succeeded. But the official opposers were not daunted. They gave up their frontal attack to start a running, flanking fight. They began a policy of pin-pricks. The instigator was their servant; they would make him suffer; and they did. But they did not at first attack him directly, but smote his kith and kin. They punished him by sending his brother, who was also their servant, to a distant post in a bad climate; then they bullied the kinsman. They tried hinted accusations against him; and at last they drove him from their service, thrusting him without warning into the world to starve. But the work went on, spreading, improving, reclaiming, converting an in-

sanitary place and making it healthy and clean. People were beginning to talk, the work was becoming known, and the instigator began to receive praise. Then the opposers raged and turned their attention to him direct. They wrote him vicious official letters. They tried to involve him in the maelstrom of financial difficulties which other departments had engendered. They demanded varying sums of money from him, beginning with a request for a large amount, with the view, apparently, of making him incriminate himself; when he refused to comply they told him they would be satisfied with a small sum just to show he was guilty—still he refused. They tried to entice him from his post by fair promises, as he, and his kinsman, had already been enticed to enter their service; they hoped the work he had started would fail in his absence. But as before, their promises were broken, and when he protested they cut his salary. Eventually the instigator was driven from their service as his brother was before him; for they curtailed his holiday and trumped up charges against him during his absence. But the work he instigated went on and continues to this day.

This occurred some years ago in a country as yet incompletely civilised; it is improbable that such a thing will occur again, for a repetition of such actions can hardly be expected. Men are becoming more sensible in this generation, and attempts at progress are more encouraged than they used to be. At the present time an instigator of an anti-fly campaign would hardly encounter such opposition, but the facts are set down here to show one of the lines of opposition which must be borne in mind. Popular approbation is a very great support, and the assistance of public sympathy should always be sought for. With this, there should

Mass of pupæ in old " flock " bedding (natural size).

(*After Newstead.*)

be but little opposition. In fact, if the anti-fly campaign is diligently continued the difficulties will decrease until they disappear.

But it must be remembered that popularity is fickle; as a supporting pillar it is often made of paper, as a castle it is based on sand. It is important, therefore, that the foundations of the work are properly fashioned and are of substance. Fly-borne disease is the foundation of anti-fly campaigns, and these can be confidently expected to stand and to bear hard knocks even as anti-mosquito-campaigns have withstood them. Fly-borne diseases are facts, and flies are facts—they are not merely the dreams of visionaries and enthusiasts. The foundations therefore are strong. Consequently the anti-fly campaigns are built on a strong basis, and it only requires perseverance to make them succeed. Sometime the beginning may fail, but the structure will remain only to be built up again and again.

Trouble may arise from the householders. These may object to the weekly visits of the inspectors or refuse them admission. Such protesting persons must be dealt with quietly and tactfully. Perhaps one of the inspectors has been impertinent or officious. Careful inquiries will soon bring such things to light, and the cause of the opposition obviated. Perhaps, in the near future, fly-larvæ will be included in the official list of "nuisances," and then flies will become the care of the magistrates. Or perhaps a Bench will respond to the appeal against flies and decide to punish persistent fly-breeders. Then a few examples will do much to produce permanent fly-reduction. But, as stated before, the law's courses should be avoided if possible. In some countries, where human habitations are grossly insanitary, a legal instrument for fly-reduction will be of the

greatest service; but even then it should be used with much discernment and discretion.

The first suggestions of mosquito-reduction produced a peculiar form of opposition which is hardly likely to be repeated. There were people who said that it would be wicked to reduce harmful insects like mosquitos, because they were sent into the world to punish sinners, and that the reduction of mosquitos would frustrate the ends of an ever-watchful and vengeful Providence. It is very difficult to answer persons who make difficulties of this nature. It is better to leave them alone. Let the mosquitos bite them or the flies annoy them—they will soon alter their opinions when they see their neighbours' children healthy and their own sick and ailing.

Perhaps organised fly-reduction will interfere with some important trade. In some places, in some rural districts, manure is utilised for agricultural purposes; and the suggestion to destroy it once every week may produce opposition from some farmers, contractors, and others. Careful inquiries will soon dispel such opposition. If the manure is to be spread out over fields or dug into land it will not breed flies; this has been proved by experiment. But if it is stacked the flies will breed in the stacks—this is because of the warmth in the stacked manure. This should be explained to those who complain, and every care must be taken that such manure is not treated with petroleum or slaked lime. The inspectors must be instructed to allow some latitude to such trades as require manure for agricultural purposes, but they must see that manure stacks are not allowed to remain for more than one week. In the spring, manure is used in suburban gardens, and it is sometimes allowed to remain in corners of such gardens

for many days before it is dug into the ground. The owners of such gardens and the tenants must be warned against this. A letter to the editors of the local newspapers early every year will accomplish much to avert the early advent of flies, for it will make the householders careful. In this way opposition will be avoided.

All opposition can generally be overcome with a little patience and tact.

## CHAPTER X

### THE JUSTIFICATION OF EXPENDITURE OF MONEY AND ENERGY

Organised fly-reduction is a matter of money. The question arises whether the expenditure of the annual sum required is likely to be justified by the results obtained. This in its turn depends on the way in which the work is carried out. Theoretically, it is justifiable to spend as large a sum as can be afforded by the public funds if the improved health of the community is obtained thereby. Public health is the greatest boon which can be conferred on the community, and it would appear that almost any sacrifice would be justified to obtain it. But practically it has been found that the term "Public Health" is a vague one, and that the public will not be satisfied with a vague term as a dividend for funds expended. If public money is expended on any sanitary work, whether it is fly-reduction or mosquito-reduction, or other means of preventing disease, some tangible result will be asked for sooner or later.

Municipalities, urban or rural district councils, will often spend considerable sums of money—raised by and dependent on local taxation—upon schemes which bring in little or no return and which are sometimes a perpetual burden on the district. Sooner or later questions will be asked about such schemes and the

matter will be sifted, and perhaps trouble will ensue. But if the scheme is a proved success and the expenditure justified by adequate dividend no questions will arise, for the results are obvious. With fly-reduction, however, the results cannot always be obvious. There are several reasons for this. The fly-population is, as has already been stated, directly related to climate. Flies may be a pest one year and almost absent the next. Therefore, the incidence of fly-borne disease varies from year to year. Consequently, it may be very difficult to say whether the reduction of fly-borne diseases in any one locality during any one year is due to organised fly-reduction or to variation of the climate. People may say that the reduction of fly-borne diseases is due to the milder summer and not to the anti-fly campaign, and the money spent has been wasted.

Yet such is not the case—the money is not wasted. The expenditure has placed the community, so far as flies are concerned, beyond the influence of vagarious weather ; and should it be hot or cold, dry or rainy, if the anti-fly campaign is efficient there is the certitude that the campaign is successful and that the fly-borne disease will not appear. In other words, the money spent is the premium of an assurance policy. This is the light in which all public-health expenditure should be regarded. In sanitary matters the public is its own insurance company insuring itself against death ; and in trying to prevent unnecessary death it is saving its own pocket.

Suppose that after a few years of fly-reduction the figures show little or no reduction in fly-borne-disease mortality. What is to be done then ? The cause of the discrepancy should be found out. Perhaps the statistics as obtained at the outset were fallacious. Or

those obtained later were wrong. It is often the case, when a disease begins to be seriously considered and its effects on the community observed, that it is discovered to be commoner than was formerly supposed. The example of appendicitis can well be cited. A hundred years ago appendicitis was rarely recognised, though sufferers died of it, while their deaths were returned as due to peritonitis or some other name; now it is an affection common and fashionable. So it will be with fly-borne disease probably. As soon as organised fly-reduction has become popular and generally carried out—as it undoubtedly will be—the frequency of fly-borne disease will come to light, and then people will begin to ask why fly-reduction was not thought of before.

Sanitation, public health, are concomitants of civilisation. Without entering into the argument of cause and effect, there is no doubt that sanitation and civilisation progress together. One of the most striking differences between a barbarous and a civilised country is that of cleanliness and sanitation. Compare India with England, Calcutta with London. One is dirtier than the other—the houses, the streets, the people. Compare Cairo with Boston, or Moscow with Paris. Then compare the death-rates—the better the civilisation the healthier the people. Climate *per se* has little influence. The Panama Canal zone, situated in one of the hottest and worst climates, has been made as healthy as New York.

Health, then, is a worthy object and worth any reasonable expenditure. Disease is an objectionable thing, inasmuch as it impedes and is contrary to the dictates of civilisation. Fly-borne disease is a loathsome thing, and its existence in a civilised country is

barbarous. But humanity will put up with many barbarous things. This is due to ignorance of their nature. Before the teachings of Edward Jenner had borne fruit, small-pox raged—a very large percentage of the population of Great Britain were pock-marked; yet there was no public outcry. People were used to it, and did not know what it was to be without small-pox in their midst. This was ignorance of public health. But now that small-pox has been banished, a case of small-pox in the community causes fear—the fear of a loathsome affection. And in a few years the presence of a case of fly-borne disease will, without doubt, produce a similar feeling.

The progress of civilisation seems to drift on unconsciously. For years after Jenner's discovery individuals strove and worked to enforce vaccination against small-pox; but it required the lapse of nearly a century before small-pox became a thing of the past in England, where the discovery was made. Even now there is occasionally a movement of infidelity against one of Nature's most beneficent arrangements. The discovery of the cause and the mode of transmission of malaria brought in its train a means of preventing one of the most devastating diseases of the tropics; but even now, fifteen years later, some intelligent Governments hesitate to apply the knowledge gained—mosquito-reduction is not universal even in malaria-stricken India or in insect-pested Egypt. Knowledge arrives slowly, scientific progress is tardy, humanity lingers long in the slough of doubt. The public will jump to its feet and will act quickly when there is a massacre of Armenians, or an ill-treatment of Congo or Putomayo natives; but if there is a preventable child-mortality in its midst, it will ponder carefully

for a hundred years before it turns its head. Cruelty is a name—there is always cruelty at home. There is nothing more cruel than the house-fly to us human beings, yet there will be hesitation before we spare expense to institute fly-reduction. If we were to be sparing in sending our medical missions to the wars or to grant relief to the widows and orphans of the latest accident or shipwreck, we should dub ourselves cruel. But the prevention of flies and mosquitos, which produce annually a far greater number of deaths than wars, accidents, or shipwrecks, is considered merely a matter of interest and then often forgotten. This apathy is due to ignorance—common, general, public ignorance. Such ignorance can only be overcome by practical example, work, advertisement, talk—but let the facts be plain and true.

Fly-reduction does not cost much. It is not nearly so expensive as many of the objects in which charity interests itself. For a few thousands of pounds our large cities could be rid of flies, and our infant mortality would fall. This would mean the saving of life, and it is surely better to pay for the saving of life than the loss of life; for there is no difficulty in obtaining funds to supply relief after fatal accidents.

Yet I am convinced that the public will encourage fly-reduction as soon as it understands its benefits. After some preliminary grumbling there will be no opposition on the score of expense. People will realise the advantages of fly-reduction. In America flies are a much greater pest than in England; this is due to the difference of climate, and organised fly-reduction will probably be instituted in America first, and then other civilised countries will follow suit. Perhaps a few

years hence, when but one or two decades have passed, the race will look back with pity at the present-day infant mortality. We can now hardly realise what small-pox used to be like a hundred years ago.

Discoveries are grasped more quickly nowadays, and their applications are more thorough than they were even in the past generation. This is because of the rapid means of intercourse between nations, the influence of advertisement, and progressive competition. As a result communities are more united than formerly, and there is less dislike to pay for innovations. If the suggested innovation is a reasonable one, and is certain to produce beneficial results quickly, the public will pay. But the matter must be suggested in a creditable manner. An insect which lives and breeds in filth—surely any reasonable individual will help to rid us of it?

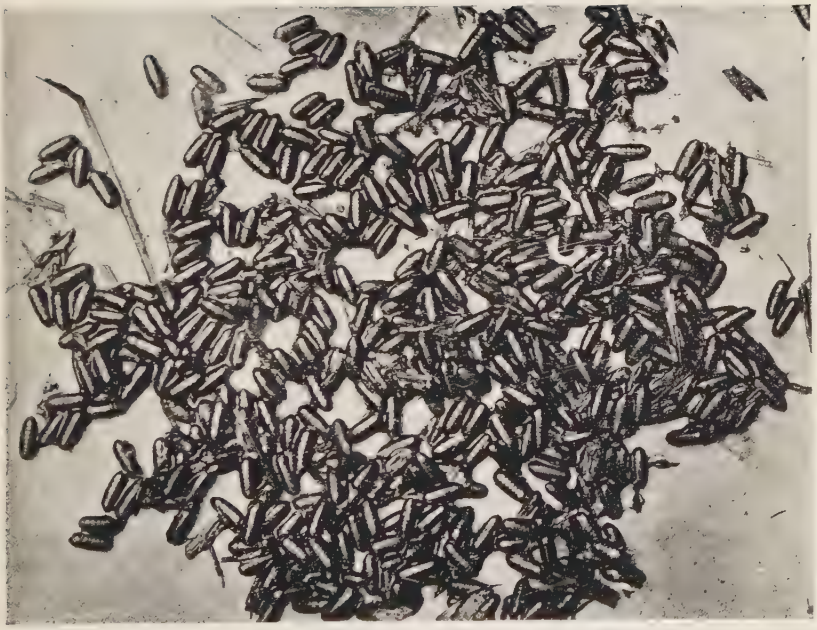
But there is the expenditure of energy to be taken into account. Well, the energy expended will have its reward. The health-officer who can reduce permanently the mortality of the people in his sanitary charge will deserve the credit of those who benefit mankind. The man who saves life deserves far more praise than the general who destroys it. Probably he will not get the praise he deserves at once; but still the knowledge is there, and sooner or later the repute due to him will be his. Then there is the advantage that fly-reduction will reap its own reward, and that the reward will vary directly with the energy expended.

## CHAPTER XI

### THE LIFE AND DEATH OF *WORRY*, THE FLY

She was born in a muck-heap. The fly-mother had laid her eggs on the floor of a butcher's stable; it was a tradesman's stable in a slum. The eggs had hatched rapidly in the warmth of the spring-time sun, and the maggots were living, eating, and crawling. Our fly-heroine was born with the others, her brothers and sisters, when the morning light diffused through the stable, and after its equine occupant had been led out with a stumble and a clatter into the yard to be harnessed into his cart. The horse had gone to do his day's work, but the flies remained to feed, and the newly hatched maggots swarmed, burrowed, fed, and thrived in their lair.

The early life of *Worry* is a story of peace and plenty. She grew rapidly, undisturbed. Every evening the horse returned, but the fly-maggot had found for herself a nook in his bedding out of reach of his stamping hoofs, for his footfall had made short work of some of her fellows; *Worry* was either wiser or luckier, and avoided this untimely death. For six days she lived and grew, shedding her skin in transparent moults as her development reached its various stages. Her larval life would have been quite uneventful but for the hen of the stable-yard who was teaching her chicks to feed, and for a mother sparrow who dropped



Mass of fly-pupæ (nymphs) separated from stable-manure (natural size).
(*After Newstead.*)

some of the fly-larvæ down the throat of a fledgeling. However, *Worry* escaped these intentions on the part of her enemies. On the seventh day of maggot life our heroine rolled herself up and entered the phase of her life known to human beings under the pretty name of "Chrysalis."

The chrysalis is a living but unheeded thing, a life within a web. *Worry* passed the hours without feeding, her body developing, like that of an ugly duckling, from a hideous youth to a beautiful maturity, from a crawling creature to a thing of gossamer wings, the development from caterpillar to moth. The world of the stable went on unnoticed within her web. The rain came down, and many of her brothers and sisters were drowned; they had crawled into the stable-yard, there to become nymphs like herself, but the rain had formed puddles between the stone flags of the yard, and they, being unable to move, had drowned. *Worry* was quite oblivious of all this, unmindful of the world outside her sphere. Slowly her wings developed, and her legs became obvious within her chrysalis shell. Then the shell opened, and *Worry* the maggot became *Worry* the fly.

Her real insect life had begun. She was to go forth into the world to do her share of its work. She shook herself free from her shell, tried her wings and legs, walked slowly and cautiously to the edge of her former home, and then gently raised herself on her pair of outstretched wings and flew quietly to the stable window-ledge. She was hungry and thirsty, and she fed on some of the filth of the place and drank from a raindrop. Afterwards she flew again and alighted on the stable floor and fed again. As the evening came on she took some gentle exercise on

the window-pane, the muscles of her body and legs gaining strength for the labours of her life. That night she slept standing head downwards on the gas-bracket—its colour matched her sombre brown and hid her from possible enemies. Her legs had become sticky, for she had put them in her food, and this enabled her claws to get a good hold on the metal.

In the early morning she woke with day and flew from her home out into the yard and obtained a meal in the dust-bin. Then she entered the house adjoining. This day was full of adventure. She met a male fly and mated with him; her consort thereupon deserted her. She tasted some jam, and inspected the larder, was attracted to cheese, but was driven out into the open by a servant girl armed with a dishcloth. She had a ride on a coster's barrow containing some fruit; she traversed some streets and slums. And her mouth and legs became infected with some disease germs which she found on a rotting banana-skin; they had been deposited there by another fly a few days before, and they had multiplied into a focus of disease during the time which had elapsed. She galumphed with delight at her freedom, for the tide of her life was at flood. She pestered a horse, and examined critically the eyes of a sleeping child; but the infant brushed her away and nearly damaged her wing. *Worry* was learning the ways of the world and knew how to avoid its dangers and how to linger over its joys. But the germs on her legs were increasing, so she tried to bathe them in a drop of milk on the edge of a jug in a dairy. The milk gave them food, and the germs grew the faster. She paid for her desire for cleanliness by nearly drowning in the milk, and this bath was the last one she had; hers was the life of pleasure,

she was queen of the air ; what matter the germs of death—they were but sticky fun to her.

Our germ-laden fly now led a life of busy days and peaceful nights. She wandered from house to house, contaminating food and milk. Sometimes she found herself imprisoned in a room, and she spent many weary hours crawling up and down the window-pane in the hope of obtaining her freedom ; she saw the daylight outside but could not understand the glass which stood between her and liberty. Some one kindly though unintentionally assisted her by opening the window, and again she set out on her wanderings. One morning she awoke in a bedroom, and she amused herself by settling persistently on the face of its sleeping occupant ; he brushed her away, and she amused herself by playing hide-and-seek with his hand. She waited until he slept again and then returned to his face once more. Again he drove her away and again she returned. This all pleased her mightily. Then she was nearly caught in the net which *Scraggy*, the spider, had spun ; but she escaped by a sidelong turn of her wings. Once she found herself in the sick-room of a child. She heard the doctor giving the nurse instructions. "The child has typhoid, and you must give her nothing but milk, good, new, fresh milk with a little water or soda-water. Please see that the patient has nothing but milk." *Worry* flew to the doctor's forehead and pestered the overworked man while the nurse went to fetch the milk for his inspection. The doctor tasted the milk ; so did the fly ; but the latter also dipped her filthy feet into the sick child's only food. *Worry* went away delighted with her adventure after having walked about on the patient's parched lips. Away she flew to the give disease to others,

to spread death, unhappiness, sickness, misery. For this was she born, and this did she do, knowing nothing and caring for nothing but the joy of a short-lived life.

The weather was becoming warm as a heat-wave approached, and *Worry* had a life of delight in the warmth, a buzzing of gladness for summer. She was up and doing always, and the children were sick and dying; but Nemesis was on her track. Among the germs on her legs were the spores of a fungus, and these were growing now in the warmth and binding and hampering her feet. She first noticed them when she went to a garbage heap to lay her eggs. She had chosen the place instinctively, because she realised that her offspring would require food when born, as she had done. Then she noticed how clumsy her feet had become, and she flew to clean them in some cream, but it made matters worse. So she settled at last on the edge of a dust-bin and there slept for a night. In the morning she found that she could hardly move, and the fungus which had begun to grow into the interstices of her chitinous skin was preventing the opening of her wings, and was relentlessly claiming her life as she had claimed others. Her freedom was passing, and the liberty she loved so well was fading from her as her foe tied her down with silken thongs. *Worry's* imprisonment was like that of Gulliver's among the Lilliputians; she was powerless, she could not move. Her legs and wings were in the vice of the canker. She was dying fettered, her life once so gay and free now slowly ebbing from her. She struggled vainly. Her eyes could see the direst enemies of her race coming cautiously towards her—black ants awaiting her end as vultures await the death of their prey. She saw first one, then another

Plan of Port Said marked into areas of daily inspection for mosquito-reduction; the same methods should be used for fly-reduction.

silently approaching and walking round and round her as she died. *Worry* rolled her head from side to side and pressed her lips to her wooden grave as the last gleam of life burned up for a moment, flickered, and then died down and at last went out. And this was the sad end of *Worry*, the fly.

But sadder still is the epilogue. *Worry* left a train of disease behind her to tell her tale. She had infected children and adults, had killed some and maimed others, and sent many to hospital. It was not her fault, but it was the fault of those who had allowed her, and still allow her to exist. A little trouble, a little care, a little perseverance, and *Worry* with her kith and kin will disappear, or at all events will diminish in numbers to such an extent as to become harmless. But she has given birth to others and these, unless controlled, will work as much harm as she did—and our children will suffer. This is the story of *Worry*, the fly.

## CHAPTER XII

### SANITARY EDUCATION, FLIES, AND THE COMING GENERATION

In the foregoing pages measures have been described which are directed chiefly against flies breeding in horse-manure. But it must always be remembered that house-flies are attracted by, and will often lay their eggs in, all kinds of filth, including waste food. The housewife, therefore, can greatly assist the organisers of the fly-campaign by constant vigil concerning the cleanliness of her house. If every citizen always kept his or her house in order there would be no insanitation and no flies. At Cardiff the municipality has made enormous strides in the housing of the poorer classes—miners and dock-labourers—and have given them sanitary cottages to live in. The streets and the exteriors of these model dwellings are all that could be invited, but the interiors of many of these houses are grossly unclean. The poorer inhabitants are not sufficiently educated in sanitary matters yet. Personal cleanliness is as important as municipal sanitation. We can all do our small share in fly-reduction by attention to the details of hygiene, and by not allowing flies in our houses or fly-larvæ on our premises. If we were all to keep our establishments clean—sanitary cleanliness—flies would neither enter our houses nor be able to breed near them ; then fly-campaigns would

Fly-pupæ in feathers and straw from a poultry-yard (natural size).
(*After Newstead.*)

not be required. Too often the word "sanitation" is regarded as merely implying drains which do not smell. And a dirty house or hotel or shop is often spoken of as being in a good sanitary condition while the reverse is the reality. The test of the sanitation of a house lies in the weekly (or daily, if possible) examination of its kitchen, its offices, its nooks, corners, and crannies, its garbage cans, sinks, swill-tubs, its ash-bins, its courtyards, its gullies, its rain-pipes, traps, and eaves, its larders, and the cleanliness of its plates and dishes, cloths, linen, and household management. Houses thus clean will rarely harbour flies or fly-borne disease. Organised fly-reduction on the lines laid down will give the best results, but in some districts the killing of individual flies may assist the organisation. We can kill a few of the individual flies which infest a house by trapping or using poisons or vapours, or by placing screens over the doors and windows to keep flies out—such measures may be of use during fly-borne epidemics; but, as stated before, we cannot thus seriously affect the total population of insects in any locality or district. The methods commonly in vogue are the use of fly-papers, fly-traps, and the employment of formalin, etc. But fly-papers and traps scattered about a house are very unsightly objects, and the use of poisons is dangerous to children and pet animals. The burning of pyrethrum powder in a house is a troublesome and often costly proceeding, and the fitting of fly-screens is unheard-of in this country. All methods of killing the flying insects are unsatisfactory. At Port Said, every conceivable method was tried to reduce the fly-*imagines* in a house, and although there was a slight reduction of the insects, no lasting benefit accrued, and it was found that the presence of numbers of dead

flies attracted swarms of ants, which did much mischief, and in their turn became a terrible pest. Everything was tried—traps, papers, formic aldehyde in saucers, the burning of Keating's Powder—and it was concluded that there were nearly as many flies as before ; as some flies were caught, killed, or died, others arrived to take their place. Fly-killing was given up as useless.

Undoubtedly fly-reduction as advised in this book holds out the best hope of reducing fly-borne disease. In several towns and cities in the United States organised fly-reduction is already in progress ; in this country, the county of Norfolk and the town of Liverpool, so far as I am aware, are alone interesting themselves in the matter through the energies of their medical officers of health. But in the State of Florida a fly-crusade has been begun by the State officials. There, according to Howard, the State Medical Association has established a fly committee, which has taken upon itself to carry information concerning these insects into every portion of the State. In other parts of America anti-fly work has been begun either by individuals or by some local organisation. The Women's Municipal League of Boston has taken up the fly-question through its department of sanitation, and is doing admirable work. There are also some established organisations in America which have started to advertise the advantages of fly-reduction.

Education of children also holds out great hopes. In all schools elementary sanitation should be taught as a routine ; and the facts known about flies and their danger to health should be included in the curriculum. Thus the rising generation will learn to limit disease, and will grow up educated in some of the methods of saving life. It required a period of ten years for the

Mass of fly-pupæ in spent hops (natural size).

(*After Newstead.*)

public to realise the importance of mosquitos as carriers of disease, and to grasp the fact that malaria and yellow fever can be prevented. Now, governments, municipalities, and local authorities are beginning to institute mosquito-reduction in many countries and in many places. It is to be hoped that fly-reduction will begin soon, but experience teaches that a generation must pass before the world learns the lessons which science, by its constant discoveries, teaches.

At San Antonio, Texas, a competition has been started among 10,000 school-children to find out and to report the mosquito-breeding places in that locality, and, as a result, these insects have been greatly reduced in numbers, and now malaria has disappeared. Here is an excellent result. In England, the Boy Scouts could be usefully employed similarly by making them find out and report the fly-lairs. It would be great work if fly-borne disease disappeared from Great Britain.

As in the case of mosquitos, however, it is not possible to exterminate flies absolutely from any given town or district. They can be reduced in numbers, but not actually abolished. But they can be reduced to a negligible quantity, and then the diseases carried by them will disappear, as has happened at San Antonio. Therefore it is necessary to persevere and to maintain the fly-campaign indefinitely. It is of little use to start a campaign against flies, to reduce their numbers, and then to become disheartened, and allow the campaign to lapse. Such a proceeding will bring the crusade into disrepute. The fly-campaign, once started, must always be kept up unflaggingly.

Caution must be exercised in drawing hasty conclusions concerning the effects of fly-reduction. Beware

of statistics showing diminution of fly-borne disease when small figures only are obtainable. For example, official health reports sometimes claim the reduction of a disease in a whole town because out of a hundred patients treated in one hospital 10 per cent. suffered from the disease compared with 15 per cent. the year before; some reports then conclude that there is a reduction of 5 per cent. of the disease throughout the town. Such an inference is not only unjustified but is actually incorrect. If deductions must be drawn from percentages and averages large numbers must be obtained, or the results may be hopelessly misleading. Usually time must elapse before disease-diminution can be justly claimed. But there is always the knowledge that such a diminution is in the making, and that the efforts will be ultimately rewarded. Therefore persist, persevere, try again and again. Be energetic and succeed.

Without doubt, fly-reduction will reap its reward. The saving of life—that is the goal. It is religion, charity, philanthropy, and the greatest aim which any one can yearn for. The highest ambition is this—the welfare of others.

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